Executive Summary
of the
U.S. Army Corp of Engineers
Chicago District's
Report

Upper Des Plaines River Flood Damage Reduction Study Interim Feasibility Report and Environmental Impact Statement June, 1999

Prepared
May, 2004

by

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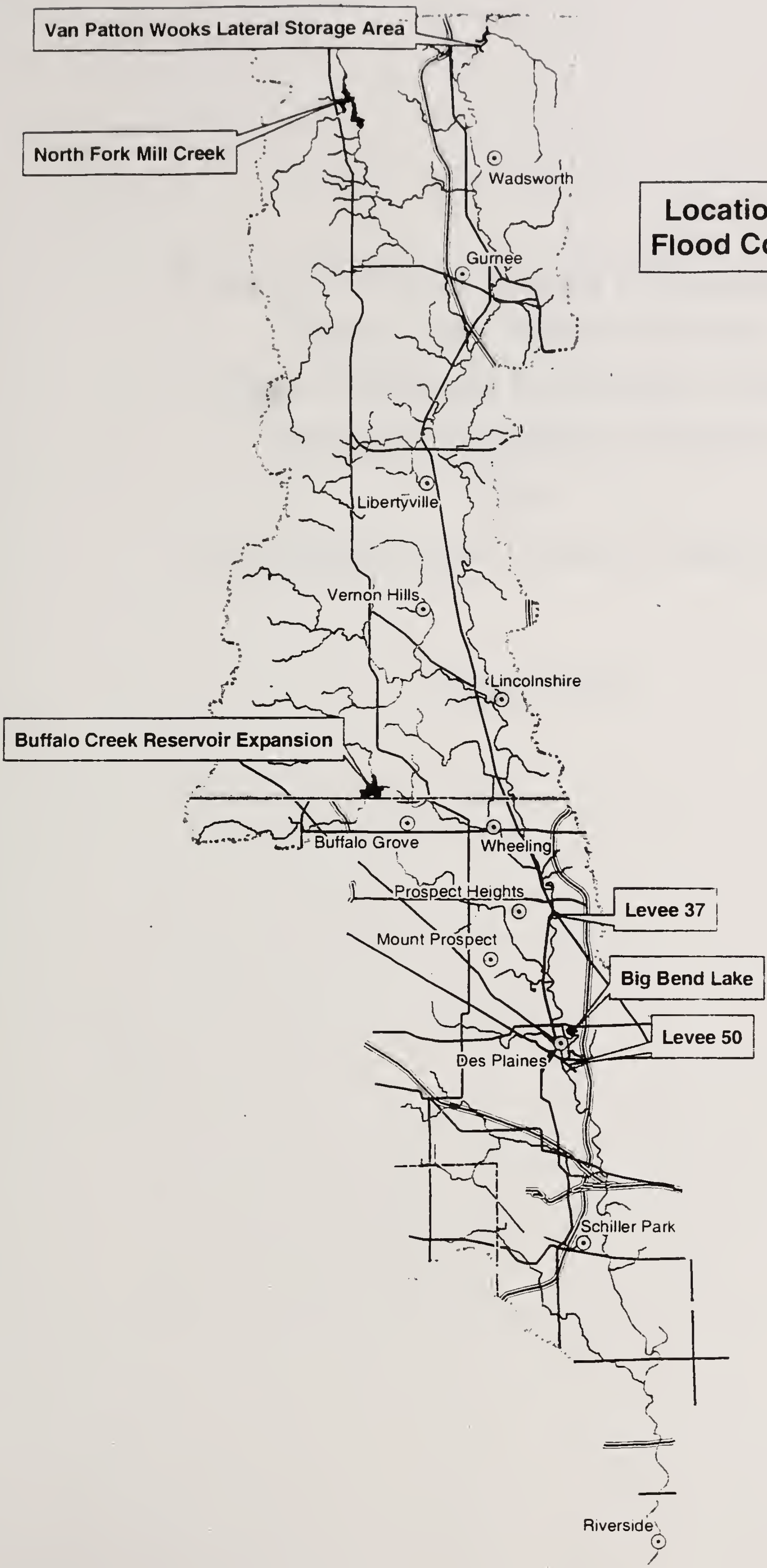
The following pages have been extracted from the report *Upper Des Plaines River Flood Damage Reduction Study, Interim Feasibility Report and Environmental Impact Statement, June, 1999* prepared by the Chicago District of the U.S. Army Corps of Engineers.

The Illinois Department of Natural Resources, Office of Water Resources (IDNR/OWR), with cooperation from other units of local governments, intends to fulfil the requirements of the non-Federal project sponsor that are discussed on pages 93-96 of the attached document. This Federal project, which was authorized in the Water Resources Development Act (WRDA) of 1999, Section 101 (b)(10), dated August 17,1999, consists of the 6 following project elements:

- Levee 50
- Levee 37
- North Fork Mill Creek Reservoir
- Van Patton Woods Lateral Storage Area
- Buffalo Creek Reservoir Expansion
- Big Bend Lake Expansion

The IDNR/OWR intends to construct the Levee 50 project element entirely with state and local resources; IDNR/OWR will construct Levee 50 and local government units will provide all necessary rights-of-way, utility relocations and operation and maintenance. The IDNR/OWR intends on participating in the implementation of the remaining 5 project elements by providing the 5% cash contribution that is discussed in Section XII.a.(3) on page 93 and by providing credits accrued from the construction of Levee 50 to the local government units for their use in satisfying all the remaining non-Federal requirements discussed on pages 93-96. The use of credits in this manner were authorized in Section 104 of 1986 WRDA.

Location of Des Plaines River Flood Control Project Elements



Excerpts From Corps of Engineers' Upper Des Plaines River Flood Damage Reduction Study Interim Feasibility Report And Environmental Impact Statement

June 1999

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I. INTRODUCTION

The Upper Des Plaines River, located in northeastern Illinois, Lake and Cook Counties, is subject to severe overbank flooding due to inadequate channel capacity to carry peak flows during major storm events. Damaging floods in this primarily urban watershed have occurred in 1938, 1948, 1950, 1954, 1957, 1960, 1962, 1965, 1972, 1974, 1976, 1979, 1986, 1987, and 1996. The 1986 and 1987 floods together caused damages exceeding $100 million. Communities along the Upper Des Plaines River that were affected include: Wadsworth, Gurnee, Lincolnshire, Wheeling, Mount Prospect, Prospect Heights, Des Plaines, Rosemont, Franklin Park, Schiller Park, River Grove, Elmwood Park, Melrose Park, River Forest, Maywood, North Riverside and Riverside. Some unincorporated regions of Cook and Lake Counties were affected as well. Flooding in these communities has impacted homes, the transportation network, commercial/industrial sites, public/municipal sites, golf courses, cemeteries, and recreation/open space areas. The local sponsors in the feasibility phase of this study were: the Illinois Department of Natural Resources, Office of Water Resources (OWR), the Metropolitan Water Reclamation District of Greater Chicago (MWRD), and the Lake County Stormwater Management Commission (SMC).

A. STUDY AUTHORITY

The Upper Des Plaines River Feasibility Study was conducted under Congressional authority known as the Chicago - South End of Lake Michigan (C-SELM) Urban Water Damage Study Authority. This authority is contained in Section 206 of the 1958 Flood Control Act (PL-85-500) as follows: "The Secretary of the Army is hereby authorized and directed to cause surveys for flood control and allied purposes including channel and major drainage improvements....(for the) Watershed of the Illinois River, at and in the vicinity of Chicago, Illinois, the Chicago River, Illinois, the Calumet River, Illinois and Indiana, and their tributaries, and any area in northeast Illinois and northwest Indiana which drains directly into Lake Michigan with respect to flood control and major drainage problems. "

B. STUDY PURPOSE

The purpose of this study is to: 1) describe and evaluate the scope of the flooding problems on the Upper Des Plaines River basin; 2) describe and evaluate alternative plans to resolve the flooding problems; and 3) select a recommended plan. The focus of this investigation is overbank flooding along the mainstem of the Upper Des Plaines River in Lake and Cook Counties, Illinois.

C. STUDY AREA AND SCOPE

The Des Plaines River originates in Racine and Kenosha Counties in southeastern Wisconsin where the basin is primarily agricultural. The river enters Illinois in Lake County, flowing southward through Cook County to Riverside, Illinois where it curves to the southwest, eventually merging with the Chicago Sanitary and Ship Canal, the Du Page River, and the Kankakee River near Joliet, Illinois to form the Illinois River. At Riverside, the river is joined by a major tributary, Salt Creek, which flows southeasterly from its headwaters in Du Page and Western Cook Counties, Illinois. The study area, as defined for the purposes of this Feasibility report, is the Upper Des Plaines River basin within Illinois, upstream of the confluence with Salt Creek at Riverside, Illinois (Plate 1). Salt Creek and its tributaries were not part of this study with respect to plan formulation; however, the hydrologic and hydraulic impacts of this tributary are included. A total of 67 river miles are included within the study boundaries.

D. PRIOR STUDIES AND RELATED STUDY REPORTS

1. State of Illinois

In 1943, the 63rd Illinois General Assembly appointed a Commission to investigate flooding in the state. A report by this Commission was submitted to the Illinois General Assembly in 1947 that outlined a scope of survey of the Des Plaines River area by the Illinois Division of Waterways. A report on Addison Creek (1950), Salt Creek (1955), and a basin report (1958) were submitted. In 1961, a "Report on Plan for Flood Control and Drainage Development for Cook, Lake and DuPage Counties" was prepared. This 1961 report outlined plans and cost estimates for major channel modifications, bridge and dam structural modifications, and two large (25,000 and 30,000 acre-ft) upstream reservoirs on the mainstem of the Des Plaines River and its Mill Creek tributary in Lake County. The channel, bridge, and dam modifications were to be constructed from Hodgkins upstream to the Village of Gurnee. The reservoirs were planned to be constructed upstream of the Village of Gurnee in Lake County. Other State of Illinois reports are listed below:

- Illinois Register, Department of Transportation, Notice of Adopted Rules, Title 92: Transportation, Chapter I: Department of Transportation, Subchapter i: Water Resources, Part 70, Floodway Construction in Northeastern Illinois.

- Report on the Regulations of Construction within the Floodplain of the Des Plaines River, Cook and Lake Counties, IDOT-DWR, 1978.

2. Soil Conservation Service

In 1971, the Soil Conservation Service (SCS), now the Natural Resources Conservation Service (NRCS), and MWRD entered into a cooperative agreement and published the report "Floodwater Management Plan, Des Plaines River" (1976). An agreement between the SCS and the Illinois Division of Water Resources (IDWR) led to the publication of "Flood Hazard Analysis, Des Plaines River Tributaries" (1981). The SCS, MWRD, and the IDWR jointly prepared a "Final Watershed Plan and Environmental Impact Statement; Lower Des Plaines Tributaries Watershed," (1985 and 1987) and the "Lower Des Plaines Tributaries Watershed, Floodplain Information Maps and Profiles" (1987).

3. U.S. Army Corps of Engineers

In 1989, the Chicago District, U.S. Army Corps of Engineers completed a Reconnaissance Report that investigated flooding along the mainstem Upper Des Plaines River. The report concluded that there was a federal interest in flood damage reduction along the Upper Des Plaines River watershed and recommended that a feasibility study be undertaken.

The District had investigated flooding in the Des Plaines watershed in prior studies initiated under the CSELM (PL 85-500) authority cited above. Those studies are listed below.

1. Plan of Study Chicago - South End of Lake Michigan - Urban Water Damage Study, 1976

2. C-SELM, Interim III Lower Des Plaines River Basin, Reconnaissance Report, 1981

Additional related reports prepared by the Chicago District include:

1. Summary of Urban Water Damage Characteristics On the Des Plaines River In Lake County, Illinois; Contract Report by Greeley and Hansen, 1974.
2. After Action Flood Report, Flooding in the Des Plaines, Fox River and North Branch Basins, September to October 1986, 1986 inter-office report.
3. Inventory and Analysis of Urban Water Damage Problems, Farmer's and Prairie Creeks, Cook County, Illinois, 1988; Prepared for the State of Illinois.
4. North Libertyville Estates Section 205 Detailed Project Report, March.

E. THE REPORT AND STUDY PROCESS

1. Planning Objectives

The Corps of Engineers (COE) policies and procedures for planning of water resources development projects are derived from several legislative and executive authorities. The basic planning guidelines are contained in the Economic and Environmental Principles and Guidelines (P&G) for Water and Related Land Resources Implementation Studies. These principles are intended to ensure proper and consistent planning by Federal agencies in the formulation and evaluation of water and related land resources implementation studies. Under the P&G, the Federal objective of water and related land resources project planning is to contribute to national economic development consistent with protecting the Nation's environment, pursuant to national environmental statutes, applicable executive orders, and other Federal planning requirements. Water and related land resources project plans are formulated to alleviate problems and take advantage of opportunities that contribute to this objective.

The Water Resources Development Act (WRDA) of 1986, Public Law 99-662, as amended by the WRDA of 1990, further specifies the items to be addressed in Corps of Engineers' planning of water resources projects. Section 904 of Public Law 99-662 as amended states as follows:

> "Enhancing national economic development (including benefits to particular regions of the Nation not involving the transfer of economic activity to such regions from other regions), the quality of the total environment (including preservation and enhancement of the environment), the well-being of the people of the United States, the prevention of loss of life, and the preservation of cultural and historical values shall be addressed in the formulation and evaluation of water resources projects to be carried out by the Secretary, and the associated benefits and costs, both quantifiable and unquantifiable, shall be displayed in the benefits and costs of such projects."

Plan formulation, and ultimately the selection of a recommended plan, is the primary component of a planning study. Plan formulation is the process of developing and evaluating alternative plans to meet the needs and desires of society. Federal water resources planning is to be responsive to State and local concerns. Accordingly, State and local participation is encouraged in all aspects of water resources planning. The planning process consists of the following major steps:

1. Specification of the water and related land resources problems and opportunities (relevant to the planning setting) associated with the Federal objective;

2. Inventory, forecast, and analysis of water and related land resource conditions within the planning area relevant to the identified problems and opportunities;

3. Formulation of alternative plans;

4. Evaluation of the effects of the alternative plans;

5. Comparison of alternative plans; and

6. Selection of a recommended plan based upon the comparison of alternative plans.

Plan formulation is a dynamic process with various steps that are iterated one or more times. Various alternative plans are formulated in a systematic manner to ensure that all reasonable alternatives are evaluated. These include a plan that maximizes net national economic development (NED) benefits, consistent with the Federal objective. This plan is identified as the NED plan.

The culmination of the planning process is the selection of the recommended plan among the candidate plans, or the decision to take no action. The selection is based on a comparison of the effects of alternative plans and consideration of how well each plan meets the criteria of completeness, effectiveness, efficiency, and acceptability. The recommended plan should be the alternative plan with the greatest net economic benefits consistent with protecting the Nation's environment (the NED plan). If not, the reasons for selecting some other alternative must be clearly and thoroughly explained, and be consistent with Corps policy. (ER 1105-2-100, Chapter 5, Section II).

2. The Report

This feasibility report consists of a main report, an Environmental Impact Statement, and ten appendices. The main report gives background information on the study, documents the planning process, and present the conclusions and recommendations reached during the study. It presents the development of the Preliminary Corps Plan and the further development of the plan supported by both the Federal government and the local sponsors (i.e., the Recommended Plan). The level of design detail is sufficient to support the essential analyses and conclusions of the study based on the engineering, economic, environmental, and social analyses performed. The main report is structured in accordance with the six major planning steps discussed in the preceding section on the planning process. The ten appendices are as follows:

Appendix A - Hydrology and Hydraulics
Appendix B - Civil Design
Appendix C - Cost Estimating
Appendix D - Geotechnical Engineering
Appendix E - Economic Analysis
Appendix F - Coordination
Appendix G - Real Estate
Appendix H - HTRW
Appendix I - Flood Warning Plan
Appendix J – Plan Formulation

II. STUDY AREA PROFILE

The purpose of this section is to present a profile of existing conditions within the study area. The profile includes the natural, environmental, and human resources of the area, as well as the development, economy, and trends of the region. The profile provides a frame of reference for discussion of the problem and needs of the area, and the impacts of the various alternative plans considered to meet these needs.

A. PHYSICAL SETTING

The Des Plaines River originates in Racine and Kenosha Counties in southeastern Wisconsin where the basin is primarily agricultural. The river enters Illinois in Lake County, flowing southward through Cook County to Riverside, Illinois where it turns sharply east and then curves to the southwest. At Riverside, the river is joined by a major tributary, Salt Creek, which flows southeasterly from its headwaters in DuPage and Western Cook Counties, Illinois. The drainage area of the watershed at Riverside, including Salt Creek, is 630 square miles. The study area, as defined for the purposes of this Feasibility report, is the Upper Des Plaines River basin within Illinois upstream of the confluence with Salt Creek at Riverside, Illinois.

1. Regional Soils and Geology

The Des Plaines River is a primary drainage feature in northeastern Illinois. The river valley can be as wide as one mile, with the river channel itself on the order of 200 to 250 feet wide. Geologically, the location of the river channel appears to have meandered within the ancient floodplain.

Glacial till and glaciolacustrine and glaciofluvial deposits are the major materials deposited on top of the Silurian dolomite bedrock in Lake and Cook Counties. The major topographic features in these counties reflecting the influence of glacial deposition include both broad and narrow, north-south trending hilly ridges (moraines); till plains and sand and gravel outwash plains; a few knob-like hills of sand and gravel (kames); and the Sag Valley and Fox and Des Plaines River Valleys that were drainage ways for glacial meltwaters. Sand and gravel accumulated as valley trains along these rivers.

Till is the most abundant glacial overburden material in Lake and Cook Counties. This material consists of unsorted debris deposited by glacial ice and is composed of pebbles, cobbles, and boulders embedded in a matrix of clay, silt, and sand. Because of extensive urbanization, there are many areas of Cook County where geologic materials have

been affected by human activities. It is recognized that a few feet of miscellaneous fills and/or regraded topsoil and other surficial material underlie most of the metropolitan Chicago area.

Within the Des Plaines River Valley, the surficial soils are primarily alluvial deposits consisting of varying amounts of clay, silt, sand, and sometimes gravel. These deposits generally range from 20 to 35 feet thick, but in some extend down to bedrock. The alluvium is underlain by clean, medium textured sand and gravel varying in thickness from 25 to 30 feet. Bedrock is expected to lie at depths greater than 60 feet.

2. Climate

The climate in northeastern Illinois is continental, with a wide variation in temperatures from summer to winter. The average summer temperature is 71°F while 25°F is the average winter temperature. Average precipitation is around 32-36 inches per year including an annual average snowfall of 39 inches.

3. Hydrologic and Hydraulic Characteristics

The Upper Des Plaines River flows generally south from its headwaters in Racine County, Wisconsin to its confluence with Salt Creek near Riverside, Illinois. The Des Plaines River then flows southwesterly from Riverside to its confluence with the Chicago Sanitary and Ship Canal near Lockport, Illinois. The watershed is aligned primarily along a north-south axis with a length of 82 miles and an average width of 9 miles. The rise of the Des Plaines from Lockport to its junction with the Root River in Wisconsin is about 130 feet, or an average of 1.3 feet per mile.

The Des Plaines River was modeled from its junction with the Root River in Wisconsin to its confluence with Salt Creek in Illinois. The Des Plaines has 15 major tributaries in the modeled reach: Brighton Creek, Kilbourne Road Ditch and the Root River in Wisconsin, and Mill Creek, Bull Creek, Indian Creek, Buffalo-Wheeling Creek, McDonald Creek, Weller Creek, Willow-Higgins Creek, Crystal Creek, Silver Creek, Salt Creek, Addison Creek, Flag Creek and Sawmill Creek in Illinois.

Most of the southern half of the watershed is fully developed. The open areas remaining in the watershed are primarily golf courses, forest preserves, parks and cemeteries. The northern portion of the watershed continues to be developed as a primarily residential area with some commercial development.

During this century, there have been a number of flood control and flow control modifications undertaken in the Des Plaines watershed. These have included dams, channel modifications, and reservoirs. A complete list of the projects is contained in Appendix A, Hydrology and Hydraulics.

B. OVERALL ENVIRONMENTAL DESCRIPTION OF PROJECT STUDY AREA

The Des Plaines River originates in Kenosha and Racine counties in southeastern Wisconsin and enters Lake County near Russell, Illinois. As it flows southward toward the southern limit of the project study area, at Riverside, Illinois it passes through mostly residential/agricultural land and forest preserve district lands. Most of the study area is densely populated with considerable development in areas adjacent to the river's floodplain. Despite the highly urbanized character of much of the project study area, the river still has many natural, scenic, and recreational characteristics. Furthermore, the Upper Des Plaines River is atypical of urban streams because it has riparian woods along 34% of its length, in-stream cover of over 8.5%, and retains many of its natural meanders. The bottom consists of approximately 29% gravel, cobble, boulders, and bedrock and 71% fines. This is particularly true for that stretch of the river north of Wheeling, Illinois that is listed in the Nationwide Rivers Inventory as a candidate for scenic and recreational status. Both Cook and Lake Counties have set aside significant floodplain acreage adjacent to the river for recreational use.

1. Air, Water, and Sediment Quality

Air , water, and sediment quality in the project area are typical of what would be expected in a high population density area. Air quality is categorized as moderate to good, with Lake County having generally better quality than Cook County. Most of the impacts to air quality in this area are due to the large number of cars and trucks driven on the extensive road system in the Chicago metropolitan area. The Illinois EPA's rating for water quality of the area varies from good to fair in Lake County and fair to poor in Cook County. The water quality has been adversely affected by runoff from the agricultural areas and sewage outfalls from adjacent cities. Sediment quality in the Des Plaines generally follows the same pattern as water quality. As a result of efforts by the State of Illinois and local communities, water and sediment quality have improved significantly over the past 20 years. A thorough evaluation of the air, water and sediment quality of the Des Plaines River is contained in the attached Environmental Impact Statement.

2. Aquatic Communities

The Des Plaines River in the project area only supports a marginal fishery and aquatic communities north of Libertyville, Illinois. The generally lower water and sediment quality south of Libertyville does not support any major fishery of quality aquatic communities. Illinois EPA aquatic life support categories range from full support to moderate impairment in Lake County and from minor impairment to non-support in Cook County. In general, the aquatic community composition represents a continuum from species adapted to more pristine conditions (e.g., northern pike, largemouth bass, spotfin shiner, ephemeropterid insects, and freshwater clams) to those commonly associated with polluted conditions (e.g., carp, green sunfish, white sucker, chironomid insects, oligochaeta worms, and freshwater snails). Notable exceptions are found in portions of the Des Plaines River north of Libertyville and at isolated areas further downstream. Consistent with improvements in water and sediment quality there has been an increase in species abundance, species diversity, and the number of pollution intolerant species in both Lake and Cook counties during the past 20 years.

3. Terrestrial Communities

The Des Plaines River basin provides good habitat for a number of wildlife species. The combination of both wetland and upland areas along the river creates a good interspersion of habitat types along the river. Predominant wetland communities in the Des Plaines River project area include forested, emergent, and scrub/shrub types. Limited areas of moderate to high quality sedge meadow, wet and mesic prairie, bottomland hardwoods, and oak savannas can still be found in the project study area, particularly north of Libertyville, Illinois and in the Mill Creek drainage basin. One such area (approximately 180 acres) is the Wadsworth Prairie Nature Preserve and Wadsworth Natural Prairie Area just north of Wadsworth, Illinois. The majority of the wetland and upland woodland communities along the Des Plaines have been degraded due to development activities resulting in adverse impacts to water and sediment quality. As a result, many of the wetland communities are dominated by non-native and invasive species (e.g., reed canary grass, buckthorn, boxelder, eastern cottonwood, and green ash). The State of Illinois, Lake County Forest Preserve District, and Cook County Forest Preserve District have programs in place that are starting to restore some of these degraded wetlands.

4. Threatened and Endangered Species

One Federal and eleven state-listed species have been observed or may occur in the study area. These include six species of birds, four plant species, one fish species, and one snake species, the massasauga rattlesnake, known to occur in Cook County. Two state-listed bird species (black-crowned night heron and double-crested cormorant) are the only species known to occur at or near any of the proposed sites. One species, the Iowa darter had been sighted more than 10 years ago at one of the proposed sites. Additional discussion on Threatened and Endangered Species is contained in the Environmental Impact Statement.

C. ARCHAEOLOGICAL AND HISTORIC PROPERTIES

The Upper Des Plaines River has many upland, terraced, and other high ground areas in the project study area. These areas are known to be likely locations for prehistoric occupation sites. Limited portions of the study area have been previously surveyed by the Illinois State Historic Preservation Agency. Twenty-three known sites have been identified in a two mile reach of floodplain just south of Wadsworth Road. Phase I Archaeological Surveys have been performed at most of the project sites, with survey work planned for the remaining sites before the initiation of construction. Additional information is contained in the Environmental Impact Statement.

D. SOCIAL AND ECONOMIC SETTING

The major portion of the project study area lies within the Chicago metropolitan area, has moderate to high housing values and income levels, has an ethnic composition that is predominately white, and contains good recreational facilities. As of 1990, only three of the 39 communities in the study area could be considered rural including: Mettawa, Old Mill Creek and Wadsworth. The most densely populated areas are located in Cook County which has a total estimated 1992 population of over 5.0 million. Lake County has an estimated 1992 population of about 0.75 million. However, recent population growth has been greater in Lake County than in Cook County from 1980 to 1992, 9.81% vs. -2.18%, respectively. This greater growth trend for Lake County is projected to continue to at least 2010.

Median housing values and household incomes for the project study area were moderate to high. In Lake County, these values ranged from $72,000 (Waukegan) to $500,000 (Mettawa) for housing and $31,315 (Waukegan) to $125,074 (Riverwoods) for median household income. For Cook County the median housing values ranged from

$67,800 (Maywood) to $289,600 (Northfield) and median household income from $30,572 (Forest Park) to $75,412 (Northfield).

Thirty-four of the communities had 90 percent or more of their populations comprised of whites. Of the five communities that had non-white ethnic groups that exceeded 10 percent of the population, four were in Cook County (Bellwood, Broadview, Forest Park, and Maywood) and one in Lake County (Waukegan). The major non-white ethnic group in these communities, accounting for 13.1 to 71.6 percent of the population, were African-American.

Much of the land that the river runs through is owned by the Lake and Cook County Forest Preserve Districts. These lands are maintained principally as plant and wildlife preserves. As such they provide major aesthetic, picnicking, hiking, and recreational opportunities to the communities within the project study area.

Table 1 contains current and projected population data for 38 primary Des Plaines River communities. The five communities affected by Des Plaines River overbank flooding having the greatest populations are the City of Des Plaines (54,037), the Village of Mount Prospect (53,315), the City of Park Ridge (36,395), the Village of Elmwood Park (23,230), and the Village of Wheeling (30,442). More detailed information on housing, population characteristics and other demographic information is contained in the Environmental Impact Statement (EIS) and Appendix E, Economics.

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Table 1 - Population Trends in Primary Upper Des Plaines River Basin Communities

Municipality	1980 Population[1].	1992 Population [3].	% Change 1980-1992	2010 Population [2].	% Change 1992-2010
Arlington Heights	66,116	76,518	15.73%	79,444	3.82%
Bellwood	19,811	21,234	7.18%	18,121	-14.66%
Broadview	8,618	8,832	2.48%	8,137	-7.87%
Brookfield	19,395	19,037	-1.85%	17,892	-6.01%
Buffalo Grove	22,230	39,870	79.35%	46,018	15.42%
Des Plaines	53,568	54,037	0.88%	62,762	16.15%
Elmwood Park	24,016	23,230	-3.27%	21,625	-6.91%
Forest Park	15,177	14,966	-1.39%	15,120	1.03%
Franklin Park	17,507	18,273	4.38%	16,047	-12.18%
Gurnee	7,179	16,259	126.48%	24,753	52.24%
Hawthorne Woods	1,658	4,972	199.88%	8,357	68.08%
Libertyville	16,520	19,457	17.78%	25,379	30.44%
Lincolnshire	4,151	4,488	8.12%	6,757	50.56%
Long Grove	2,013	4,927	144.76%	6,691	35.80%
Lyons	9,925	9,827	-0.99%	8,944	-8.99%
Maywood	27,998	27,798	-0.71%	26,531	-4.56%
Melrose Park	20,735	20,582	-0.74%	17,922	-12.92%
Mettawa	330	366	10.91%	891	143.44%
Mount Prospect	52,634	53,315	1.29%	53,976	1.24%
Mundelein	17,053	22,969	34.69%	35,499	54.55%
Niles	30,363	28,083	-7.51%	34,331	22.25%
Norridge	16,483	14,192	-13.90%	15,612	10.01%
Northlake	12,166	12,714	4.50%	11,205	-11.87%
North Riverside	6,764	5,913	-12.58%	6,595	11.53%
Old Mill Creek	84	76	-9.52%	1,031	1256.58%
Park Ridge	38,704	36,395	-5.97%	34,359	-5.59%
Prospect Heights	11,808	15,365	30.12%	15,168	-1.28%
River Forest	12,392	11,896	-4.00%	11,574	-2.71%
River Grove	10,368	9,965	-3.89%	9,464	-5.03%
Riverside	9,236	9,010	-2.45%	8,419	-6.56%
Riverwoods	2,804	2,927	4.39%	4,322	47.66%
Rosemont	4,137	3,878	-6.26%	3,425	-11.68%
Schiller Park	11,458	11,026	-3.77%	10,070	-8.67%
Stone Park	4,273	4,455	4.26%	4,246	-4.69%
Vernon Hills	9,827	17,097	73.98%	24,342	42.38%
Wadsworth	1,104	2,087	89.04%	2,181	4.50%
Waukegan	67,653	69,686	3.01%	76,068	9.16%
Wheeling	23,266	30,442	30.84%	40,164	31.94%
COLUMN TOTALS	679,524	746,164	9.81%	813,442	9.02%
LAKE COUNTY TOTALS	440,372	541,047	22.86%	640,700	18.42%
COOK COUNTY TOTALS	5,253,655	5,139,341	-2.18%	5,567,400	8.33%

1 Northeastern Illinois Planning Commission compilation from U.S. Census Bureau.

2 Northeastern Illinois Planning Commission forecasts: 5 Dec. 1990.

3 U.S. Census Bureau population estimates for 1992 from BEA Electronic Form release of 8 Feb. 1994, as compiled by the Northeastern Illinois Planning Commission.

III. PROBLEM IDENTIFICATION AND ANALYSIS

A. FLOOD DAMAGE ASSESSMENT

Flood damage assessment was carried out to determine the impact from flooding on the Upper Des Plaines watershed, and to confirm a federal interest in flood damage reduction associated for the area. An assessment of the existing conditions in the watershed served two purposes: 1) they provided an indication as to the magnitude of the flood problem; and, 2) provided a measurement tool with which flood damage reduction alternatives could be evaluated. Further details on the problem identification and existing conditions analysis are contained in the remainder of this section.

1. Definition of Terms

The probability of general flooding is defined in terms of exceedance probability in any given year. For example, events defined as 0.2%, 1%, 2%, and 10% events have their respective chances of being equaled or exceeded in any given year. These events have been commonly termed the 500-year, 100-year, 50-year, and 10-year events, respectively. The general conversion from probability (expressed in percent) to a return period expressed in years is 100/(exceedance probability). Throughout this report the potential for flood elevations and flows being equaled or exceeded will be expressed in both formats described above. Another statistical term, risk, will be used throughout the report. Risk-based analyses allow for the systematic analytical evaluation of the uncertainty of the parameters that are used in the determination of the basic flood probabilities defined in this report. Risk-based analyses are described in more detail later in the report with supporting documentation in Appendix A, Hydrology and Hydraulics, Appendix E, Economics, and Attachment 2, Risk Analysis.

2. Historic Floods

Damaging floods have occurred in the Des Plaines River basin during 1938, 1948, 1950, 1954, 1957, 1960, 1962, 1965, 1972, 1974, 1976, 1979, 1986, 1987, and 1996. The two most recent major floods (September-October 1986 and August 1987) together caused more than $100 million in damages to more than 10,000 residential, commercial, or public structures. More than 15,000 residents were evacuated during the 1986 flood. Historical flood stage elevations and flows at several gaging stations on the Des Plaines River and its major tributaries are listed on Table 2.

Table 2 - Historical Flood Flows and Stages in the Des Plaines River Basin

Year	Gage Station	Elevation NGVD (Feet)	Flow (CFS)	Flow Event Frequency[1]
1938	DPR/Des Plaines, IL	635.31	5,000	25-year
	DPR/Riverside, IL	-	5,540	5-year
1948	DPR/Gurnee, IL	659.50	2,620	10-year
	DPR/Des Plaines, IL	635.31	5,000	25-year
	Salt Creek/Western Spring, IL	632.93	1,920	25-year
	DPR/Riverside, IL	602.98	6,510	10-year
1950	DPR/Gurnee, IL	658.30	1,780	5-year
	DPR/Des Plaines, IL	634.11	4,040	10-year
	Salt Creek/Western Spring, IL	632.33	1,360	5-year
	DPR/Des Plaines, IL	634.51	6,340	10-year
1954	DPR/Gurnee, IL	656.90	960	2-year
	Buffalo Creek/Wheeling, IL	664.00	268	2-year
	DPR/Des Plaines, IL	629.61	1,800	2-year
	Salt Creek/Western Springs, IL	633.23	1,710	10-year
	Addison Creek/Bellwood, IL	627.15	598	5-year
	DPR/Riverside, IL	602.88	6,340	10-year
1957	DPR/Gurnee, IL	656.10	745	2-year
	Buffalo Creek/Wheeling, IL	664.90	430	2-year
	DPR/Des Plaines, IL	631.51	2,610	2-year
	McDonald Creek/Mt. Prospect, IL	646.12	430	5-year
	Weller Creek/Des Plaines, IL	647.42	668	2-year
	Addison Creek/Bellwood, IL	626.35	560	5-year
	DPR/Riverside, IL	602.68	5950	10-year
1960	DPR/Russell, IL	671.70	1,320	5-year
	DPR/Gurnee, IL	660.90	3,070	25-year
	Buffalo Creek/Wheeling, IL	664.20	457	2-year
	DPR/Des Plaines, IL	634.91	4,670	25-year
	McDonald Creek/Mt. Prospect, IL	645.12	261	2-year
	Weller Creek/Des Plaines, IL	646.02	562	2-year
	Salt Creek/Western Springs, IL	632.13	1,220	2-year
	DPR/Riverside, IL	602.18	5,500	5-year
1962	DPR/Russell, IL	770.02	820	2-year
	DPR/Gurnee, IL	659.50	2,140	5-year
	Buffalo Creek/Wheeling, IL	663.60	318	2-year
	DPR/Des Plaines, IL	632.61	2,820	5-year
	DPR/Riverside, IL	601.48	4,230	2-year
1965	DPR/Russell, IL	669.50	600	2-year

1 Flow event frequency based on modeling used prior to the preliminary Flood Insurance Study for the mainstem that was submitted to FEMA by the Corps of Engineers in January 1996.

Table 2 - Historical Flood Flows and Stages in the Des Plaines River Basin, continued

Year	Gage Station	Elevation NGVD (Feet)	Flow (CFS)	Flow Event Frequency
1965	DPR/Gurnee, IL	658.20	1,520	2-year
	Buffalo Creek/Wheeling, IL	663.40	274	2-year
	DPR/Des Plaines, IL	630.51	2,160	2-year
	Addison Creek/ Bellwood, IL	624.65	434	2-year
	DPR/Des Plaines, IL	632.41	3,200	2-year
1972	DPR/Russell, IL	670.10	816	2-year
	DPR/Gurnee, IL	658.50	1,750	5-year
	Buffalo Creek/Wheeling, IL	665.90	802	10-year
	DPR/Des Plaines, IL	632.41	2,710	2-year
	McDonald Creek/Mt. Prospect, IL	645.72	664	10-year
	Weller Creek/Des Plaines, IL	646.32	1,280	10-year
	Salt Creek/Western Spring, IL	633.53	1,790	25-year
	Addison Creek/Bellwood, IL	625.65	706	10-year
	DPR/Riverside, IL	602.28	5,460	5-year
1974	DPR/Russell, IL	671.30	1,690	10-year
	DPR/Gurnee, IL	659.40	2,140	5-year
	Buffalo Creek/Wheeling, IL	664.90	424	2-year
	DPR/Des Plaines, IL	631.81	2,480	2-year
	McDonald Creek/Mt. Prospect, IL	644.92	291	2-year
	Weller Creek/Des Plaines, IL	640.42	673	2-year
	Salt Creek/Western Spring, IL	632.33	1,160	2-year
	Addison Creek/Bellwood, IL	623.45	428	2-year
	DPR/Riverside, IL	601.48	4,290	2-year
1976	DPR/Russell, IL	672.80	1,990	10-year
	DPR/Gurnee, IL	660.10	2,590	10-year
	Buffalo Creek/Wheeling, IL	665.10	458	2-year
	DPR/Des Plaines, IL	632.11	2,600	2-year
	McDonald Creek/Mt. Prospect, IL	644.92	305	2-year
	Weller Creek/Des Plaines, IL	642.22	887	5-year
	Salt Creek/Western Spring, IL	632.83	1,460	5-year
	Addison Creek/Bellwood, IL	623.75	454	2-year
	DPR/Riverside, IL	601.88	4,830	5-year
1979	DPR/Russell, IL	671.70	1,320	5-year
	DPR/Gurnee, IL	660.60	2,860	25-year
	Buffalo Creek/Wheeling, IL	664.90	409	2-year
	DPR/Des Plaines, IL	633.61	3,430	5-year
	McDonald Creek/Mt. Prospect, IL	644.72	246	2-year
	Weller Creek/Des Plaines, IL	642.62	919	5-year
	Salt Creek/Western Spring, IL	633.43	1,930	25-year
	Addison Creek/Bellwood, IL	624.95	591	5-year
	DPR/Riverside, IL	602.58	5,870	10-year

Table 2 - Historical Flood Flows and Stages in the Des Plaines River Basin, continued

Year	Gage Station	Elevation NGVD (Feet)	Flow (CFS)	Flow Event Frequency - old modeling [2]	Flow Event Frequency - new FIS modeling [3]
1986	DPR/Russell, IL	672.80	1,640	10-year	10-year
	DPR/Gurnee, IL	662.30	3,530	50-year	20-year
	Buffalo Creek/Wheeling, IL	665.40	581	5-year	
	DPR/Des Plaines, IL	637.20	4,900	25-year	20-year
	McDonald Creek/Mt. Prospect, IL	643.72	163	2-year	
	Weller Creek/Des Plaines, IL	639.92	629	2-year	
	Salt Creek/Western Spring, IL	632.96	1,720	10-year	
	Addison Creek/Bellwood, IL	626.55	580	5-year	
	DPR/Riverside, IL	603.55	7,625	25-year	20-year
1987	Buffalo Creek/Wheeling, IL	665.94	717	10-year	
	DPR/Des Plaines, IL	635.08	3,370	5-year	5-year
	McDonald Creek/Mt. Prospect, IL	646.20	806	25-year	
	Weller Creek/Des Plaines, IL	648.92	1,490	25-year	
	Salt Creek/Western Spring, IL	635.47	3,540	500-year	
	Addison Creek/Bellwood, IL	630.49	1,120	500-year	
	DPR/Riverside, IL	604.58	9,770	200-year	200-year

[2] Flow event frequency based on modeling used prior to the preliminary Flood Insurance Study for the mainstem that was submitted to FEMA by the Corps of Engineers in January 1996.
[3] Flow event frequency based on the modeling for the preliminary Flood Insurance Study for the mainstem that was submitted to FEMA by the Corps of Engineers in January 1996.

1986 Flood Event

In Fall 1986, the northeastern portion of Illinois experienced a period of extended rainfall, 21 September through 4 October, during which not one day passed without a majority of rain gages recording precipitation in the three county (Lake, Cook, and McHenry) area. Rainfall in excess of 1 inch per day was recorded multiple times at many gages; a few gage readings in excess of 3 inches per day were recorded as well. The cumulative precipitation at four gages in the Des Plaines River basin during this 14 day storm period ranged from 6.61 inches to 12.89 inches (normal monthly rainfall is approximately 3 inches).

The flooding in northeastern Illinois during 1986 was declared a "major disaster" by the President on 7 October 1986. This flood caused damage to over 4,000 homes, more than 600 businesses, and dozens of public structures and facilities with a large portion of these damages occurring within the Des Plaines River basin. Widespread damage was noted virtually without exception throughout the 67 mile length of the watercourse.

1987 Flood Event

Flooding in 1987 occurred as a result of a major storm on 13 and 14 August that established an all-time record of 9.35 inches of rainfall in less than 30 hours at O'Hare Airport. The storm centered on Cook and DuPage Counties and most of the flood damage occurred on Salt Creek and the lower portion of the study area. The flow rate at Riverside corresponded to approximately the 0.5% frequency (200 year recurrence interval) event. In Cook County, nearly 9,000 buildings were affected by flooding or sewer backup. On 21 August 1987, for the second time in ten months, the President declared a portion of the study area a "major disaster."

1996 Flood Event

Flooding is recorded on virtually an annual basis in certain reaches of the study area. Typical is the flood of May 1996; cumulative precipitation at the Gurnee gage totaled 4.7 inches over 6 days, with over 3 inches falling in one day. Although the area was not declared a federal disaster, significant damages resulted from the flood. The damages occurred in several areas along the mainstem and several tributaries to the Des Plaines River. No deaths were reported but community emergency crews were activated to prepare evacuation plans and assist with sandbagging efforts. The communities most affected by this flood included: Wheeling, Mt. Prospect, Prospect Heights, Des Plaines, Gurnee, Lincolnshire, and Libertyville.

These areas experienced basement flooding, some first floor flooding and road closures plus the cost of activation of emergency crews. Preliminary estimates showed the Russell Road gage crested near the 20 percent chance exceedance event on 23 May 1996, the Gurnee gage crested near a 40 percent chance exceedance event on 24 May 1996, and the Des Plaines gage was estimated to have crested between the 20 percent and 10 percent chance exceedance event on 21 May 1996. Finally, the Riverside gage crested between near the 50 percent chance exceedance event on 22 and 23 May 1996. The above stated frequencies associated with the 1996 event were taken from current discharge-frequency curves developed for this report at the four Des Plaines River mainstem gages.

3. Sources of Flooding

The Upper Des Plaines River basin is subject to storm water damage due to a variety of causes:

1. River overbank flooding (high peak stages)
2. Tributary overbank flooding aggravated by high peak river stages
3. Storm sewer backup due to tributary/river stages
4. Combined sewer backup due to tributary/river stages
5. Local ponding or sewer inadequacy and backup into basements
6. Seepage of surface and/or groundwater into basements

Often, a single localized damage area may be affected by a complicated mixture of the above flooding types. Areas of highly urban character near a tributary/river confluence that can also be in the river's floodplain are especially problematic. The last three sources of flooding listed above (sewer backup, local ponding and basement seepage) can be driven by flooding on a major watercourse that limits the capability of existing storm and combined sewer lines. The Chicago Underflow Plan Study evaluated the impacts of reduced stages on these types of flooding along the mainstem Des Plaines River. However, based on the existing flood damages not addressed by other projects, it was determined that this study would focus on overbank flooding.

4. Existing and Baseline River Stages and Flows

River stages for the 1-, 2-, 5-, 10-, 25-, 50-, 100-, and 500-year floods were computed using computer models developed by the Corps' Hydrologic Engineering Center (HEC). The HEC-1 (Flood Hydrograph Package) model computes the flow based on rainfall and drainage basin characteristics. Loss parameters and basin characteristics for the HEC-1 model were developed in conjunction with OWR. The HEC-2 (Water Surface Profile) model determines river stages based on flow rates and the hydraulic characteristics of the river channel. The hydrologic and hydraulic models were calibrated against recorded river gage data to develop the "Existing Condition" models. Detailed discussion on model development and simulation results is contained in Appendix A, Hydrology and Hydraulics.

The calibrated existing condition models were modified to incorporate the effects of planned flood control projects that will most likely be constructed by the year 2000. These models became the "Baseline Condition" models. However, the baseline condition models do not incorporate effects due to future development of the basin or future encroachments in the floodplain or floodway. Details on the development of the baseline condition models are contained in Appendix A, Hydrology and Hydraulics.

Table 3 lists flows for the 50- and 100-yr floods at a sample of gages for both existing and baseline conditions. Since the planned flood control projects in the baseline condition models focus primarily on local drainage and tributary flooding problems, there was very little difference between existing and baseline flows on the mainstem of the Des Plaines River. The difference in flows noted at the Des Plaines gage at Riverside are around 3 % for the 50 year event and 3.5% for the 100 year event.

Table 3 - Existing and Baseline Conditions HEC-1 Flows for the 50-year and 100-year Synthetic Events

Stream Gage Location	Existing Conditions		Baseline Conditions	
	50 Year Flow (cfs)	100 Year Flow (cfs)	50 year Flow (cfs)	100 Year Flow (cfs)
Des Plaines at Russell	3,086	3,773	3,086	3,773
Des Plaines near Gurnee	4,836	5,644	4,836	5,644
Des Plaines near Des Plaines	5,592	6,164	5,577	6,161
Des Plaines at Riverside	8,469	9,148	8,224	8,826

5. Expected Future Condition Flows and Stages

Future condition evaluation for the year 2010 were based on land use projections and additional statistical analysis. Future conditions hydrologic modeling was developed by a modification of the landuse characteristics in the baseline conditions hydrologic model discussed in the previous section. The future conditions HEC-1 model was used to simulate the same range of synthetic storms developed for existing and baseline conditions. A detailed discussion of the methodology, as well as a listing of the revised hydrologic parameters is contained in Appendix A, Hydrology and Hydraulics. A comparison of baseline versus future conditions flows for the 50-year and 100-year synthetic events is contained in Table 4. The difference in flows noted at the Des Plaines River gage at Riverside are very small: 0.5 % for the 50 year event and 0.25 % for the 100 year event.

Table 4 - Baseline and Future Conditions HEC-1 Flows for the 50-year and 100-year Synthetic Events

Stream Gage Location	Baseline Conditions		Future Conditions	
	50 year Flow (cfs)	100 Year Flow (cfs)	50 year Flow (cfs)	100 Year Flow (cfs)
Des Plaines at Russell	3,086	3,773	3,174	3,863
Des Plaines near Gurnee	4,836	5,644	5,097	5,910
Des Plaines near Des Plaines	5,577	6,161	5,900	6,455
Des Plaines at Riverside	8,224	8,826	8,181	8,804

6. Damage Area Identification (Reconnaissance and Feasibility Reports)

As part of the Reconnaissance stage of study, three public meetings were held in April 1988 to explain the study scope and to initiate coordination and information exchange with the local communities. Thirty separate municipalities were contacted by telephone and nineteen of these municipalities were visited by Corps' staff to exchange flood damage

information. Additional information used to identify flood prone areas included: Federal flood emergency loan data (FEMA and SBA); floodplain mappings from prior interagency studies (1973, 1975, 1987); videotapes by the Corps and the MWRD of the 1986 or 1987 floods; and various damage reports associated with the 1986 and 1987 floods (see the Upper Des Plaines River Reconnaissance Report dated February 1989 for a summary of the coordination results). This information yielded 67 potential flood problems areas and 40 major roads/streets prone to inundation along the mainstem Des Plaines River. Plate 2 shows the locations of damage areas along the river.

Additionally, 23 flood areas and 11 flood-prone roads and streets were identified in tributary areas outside of the mainstem Des Plaines River floodplain. This identification was based upon residual flood damages for the 100-year event, projected to remain after completion of the "Lower Des Plaines Tributary Watershed" project by SCS (NRCS), MWRD and IDOT. This project is hereafter referred to as SCS-project.

All potential flood problem areas identified were listed in order by descending (Des Plaines River) river mile (i.e., generally from north to south). All areas thought to be within the 100-year floodplain (including a few areas along tributary mouths) were assigned site numbers. Flood prone roads within the river floodplain were listed separately and assigned road inundation site numbers. Potential flood problem areas and road inundation that occurred within tributary floodplains were listed separately. Results from this Reconnaissance Study analysis are summarized in Appendix J, Attachment 1.

In addition to the data collected during the Reconnaissance phase, additional flood damage information was gathered for the feasibility study. Revised mapping (1990 orthophotographs) and new structure inventory information was obtained to establish structure and content values and elevations. This basic information was utilized in the analysis of existing conditions flood damages in order to better define the extent and magnitude of the flooding in the Upper Des Plaines River watershed.

The analyses employed to inventory and evaluate the extent of flood risk are described in Appendix E, Economics. From this work, the District concluded that the flooding problem was so widespread and significant that flood detention storage would be needed to address the problem, with local structural and/or non-structural plans formulated to address the residual impacts not adequately addressed by regional floodwater storage.

7. Existing and Baseline Conditions Economic Analysis

As noted in the previous sections, the existing condition of the Upper Des Plaines watershed was evaluated in order to begin the initial assessments of flood impacts. In addition to the hydrologic and hydraulic analyses, an assessment was needed of the extent of damages attributable to flooding. A description of the basic data collected for the analysis follows.

Existing Conditions Structure Damage Assessment

The Des Plaines River flooding of 1986 and 1987 served as a good indicator for the most vulnerable flood damage areas. A number of high damage areas were inventoried by the State of Illinois (for example, the community of Gurnee and the Prairie-Farmers Creek area in Des Plaines/Park Ridge). The State conducted structure inventories were adopted for use in the current evaluations. In nineteen other specially designated areas, field surveys were completed by a contractor to obtain first floor elevations and structure type information. The contract surveys covered an additional 568 structures, 418 residential single family and 150 commercial-industrial-public (CIP) and apartment/townhome units. These field survey investigations were supplemented, with a combination photographic/field survey, which used 1-foot contour-orthophoto maps to estimate first floor elevations, and windshield surveys to establish type of structure and capture observable CIP structure features. This information was used in the selection of the depth-damage function to be used in the economic analyses.

Three basic structure inventories were compiled: a single family housing inventory totaling 4,204 structures in 76 clusters; an apartment/townhome unit inventory totaling 2,286 units in 126 clusters; and a CIP structure inventory totaling 687 structures in 687 clusters. If a number of structures/units were affected by overbank flooding from a common location, then the structures/units were "clustered" and analyzed as a group at that location. Due to less common features, CIP were kept to individual structure clusters.

The inventories contain the vital parameter values necessary to evaluate flood damage potential. These parameters are: the structure location referenced to an overbank river mile point and bank designation (left or right), the structure type code used to assign an appropriate depth to damage function for structure and content, the first floor of the structure to which the depth percent damage functions are referenced, the structure value estimate, and the estimate of content value within the structure.

The depth percent damage functions used include the Federal Flood Insurance Administration curves modified for investigations into actual damage claims from the 1986 and 1987 flood events along the Des Plaines River. For CIP structures, a catalogue of stage percent damage curves developed/used at the Baltimore/Galveston Corps District offices were investigated, modified, and ultimately applied for CIP within the current study. More definitions and source references for these critical parameter values are contained in Appendix E, Economics.

Flood damage computer programs developed by the Chicago District and used in District flood damage evaluations for previously approved studies were employed to perform the multiple stage-damage computations and reporting procedures. The approved studies were the Little Calumet River Flood Control Study, the Des Plaines River Reconnaissance Report, and the North Branch Chicago River studies. In addition, the

Corps, HEC-FDA computer simulation model was utilized to capture risk and uncertainty inherent in the computer models and to optimize levee sizes.

Traffic Damages

During the 1986 and 1987 flood events, many communities experienced flooding on major roads that impeded, and in some cases prevented, normal and emergency travel resulting in significant damages. To quantify the costs of roadway flooding, the transportation analysis identified the major roads likely to flood, mapped the detour routes around the flooding, and determined the costs associated with using the detour routes. The transportation damages are classified into three categories:

1. Road flood detour costs (i.e., costs resulting from taking detour routes to avoid flooded streets).
2. Road repair detour costs (i.e., costs arising from using detour routes around roads undergoing re-construction/repair of flood damages).
3. Road repair costs (i.e., costs of damage to the physical structure of the roadway).

In addition, an associated cost of using detour routes is the rise in vehicle accidents and vehicle pollutant emissions. These incidental costs increase transportation damages by about four percent. (See Section 5, Appendix E, Economics.)

The road flood detour analysis calculated the cost of the extra time and additional mileage incurred by using detour routes over the period of time a road is flooded. The amount of time a roadway is flooded (i.e., flood duration) is a primary determinant of traffic damages. With increasing severity of flood events (i.e., from 50-year to 100-year to 500-year events), both the flood duration and number of flooded streets increase, leading to more and longer traffic detours. The analysis employed a spreadsheet model to estimate baseline and future damages, with appropriate flood duration data substituted into the model to calculate damages for with-project conditions. Road flood delay data compared normal travel times with travel times on two alternate routes during flood events. Delay costs are based on the number of vehicles detoured, time and distance involved, and duration of flood detours.

Road repair delay costs were calculated similarly to road flood detour costs, with some differences. Instead of flood duration, the key determinant was repair duration, the time a road is closed for repairs. Road repair costs quantify roadway embankment and pavement damages. Damage to the embankment and pavement depend on the flood depth and flood duration; with more water on the roadway over a longer period, a greater volume of embankment and a larger area of pavement are subject to damage. Road repair costs are based on the model for roadway and embankment flood damage developed by the Federal Highway Administration (FHWA). The FHWA model relates depth and duration of flood events with percentages of roadway affected and associates a cost with these damages.

For each affected road, comparison between expected baseline and future damages were based on depth and duration of flooding evaluations. Damage computations were provided for three categories: road flood delay, road repair delay, and road repair costs. More detailed information on the economic analysis is contained in Appendix E, Economics.

Risk Based Analysis

As required by Corps regulation ER 1105-2-101 (1 March 1996, "Risk-Based Analysis for Evaluation of Hydrology/Hydraulics, Geotechnical Stability, and Economics in Flood Damage Reduction Studies), and as advised through internal Corps coordination, an entire retro-fitting of the inventories was made to include risk and uncertainty in the analysis in a geographically and categorically comprehensive manner. To use available risk-based analysis tools (the recently released NexGen HEC Flood Damage Analysis (HEC-FDA) model), the inventory information was imported into the model and supplemented with an array of risk and uncertainty terms that could best be determined for these executions. Application of the Risk and Uncertainty methodology to the Des Plaines River is discussed in Appendix A, Hydrology and Hydraulics and Appendix E, Economics. The District contracted with the Hydrologic Engineering Center (HEC) and the Institute for Water Resources (IWR) for the use of HEC-FDA in the evaluation process. The results of their analysis is contained in Attachment 3 to Appendix A, Hydrology and Hydraulics, and in Attachment 2, Risk and Sensitivity Analysis.

Hydraulic Baseline Conditions Economic Analysis

The initial damage estimates for all damage categories were developed using the structure inventories and traffic damages in conjunction with the baseline conditions hydrologic and hydraulic modeling . As noted earlier, eight synthetic flood events (1-year, 2-year, 5-year 10-year, 25-year, 50-year, 100-year, and 500-year events) were used to define the existing and baseline conditions for modeling purposes. The baseline conditions hydrology and hydraulic models included all proposed flood protection projects that would be constructed by 2000, while the existing conditions models did not include those features. The hydraulic baseline conditions economic analysis also included adjustments for risk and uncertainty as discussed above.

Study area-wide estimates of structure and content damages for the three basic structure inventories and the three traffic categories under baseline conditions are displayed in Figure 1. Figure 2 through Figure 6 present the hydraulic baseline conditions average annual damages (AAD) by river mile for all of the damage categories, the three traffic related categories, the commercial structures, the single-family residential structures, and the multi-family residential structures. For reference, Table 5 presents roads and corresponding river miles for the study area. Hydraulic baseline estimates based on the HEC-FDA model that includes risk and uncertainty for the six damage categories are compared to the traditional analysis in Figure 7.

Single event damages for the range of baseline, without-project condition, synthetic frequency events were calculated for each river mile. Expected annual damages for hydraulic baseline without project conditions were computed. The series of profiles were then used to aggregate the damages at river miles into 26 reaches and verify the results to the single event, expected annual damage of the detailed analysis.

8. Future Conditions Economic Analysis

Future conditions, year 2010 land use, hydrologic, hydraulic, and flood damage models were developed for the study area as well. Detailed discussion of the future conditions economic analysis is contained in Section 1, Appendix E, Economics. A comparison of hydraulic baseline and future average annual damages is shown in Figure 8.

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FIGURE 1 - UPPER DES PLAINES RIVER FLOOD DAMAGES BY CATEGORY 1995 CONDITIONS

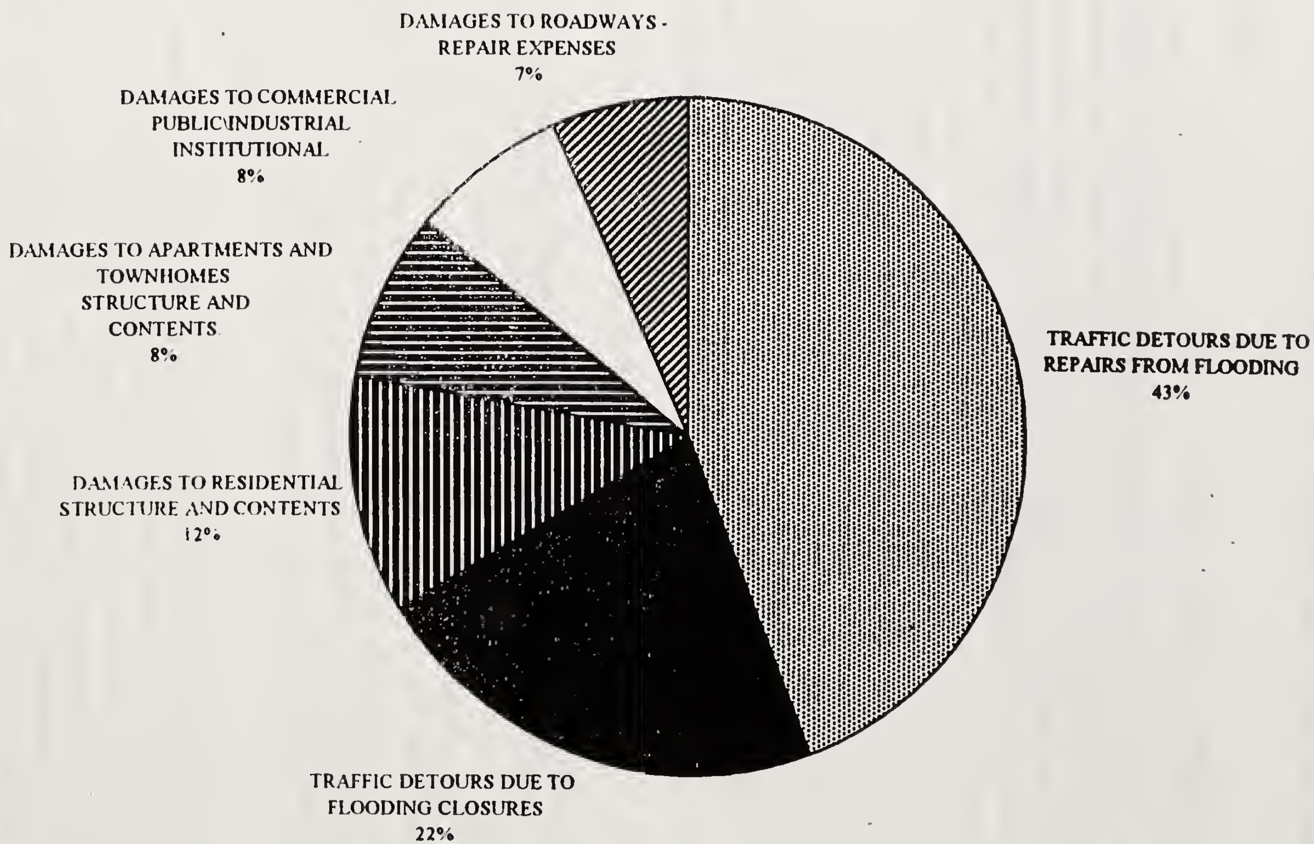


FIGURE 2 - UPPER DES PLAINES RIVER FEASIBILITY STUDY
COMPOSITE AAD ESTIMATE -1995 FLOOD STAGE PROFILE

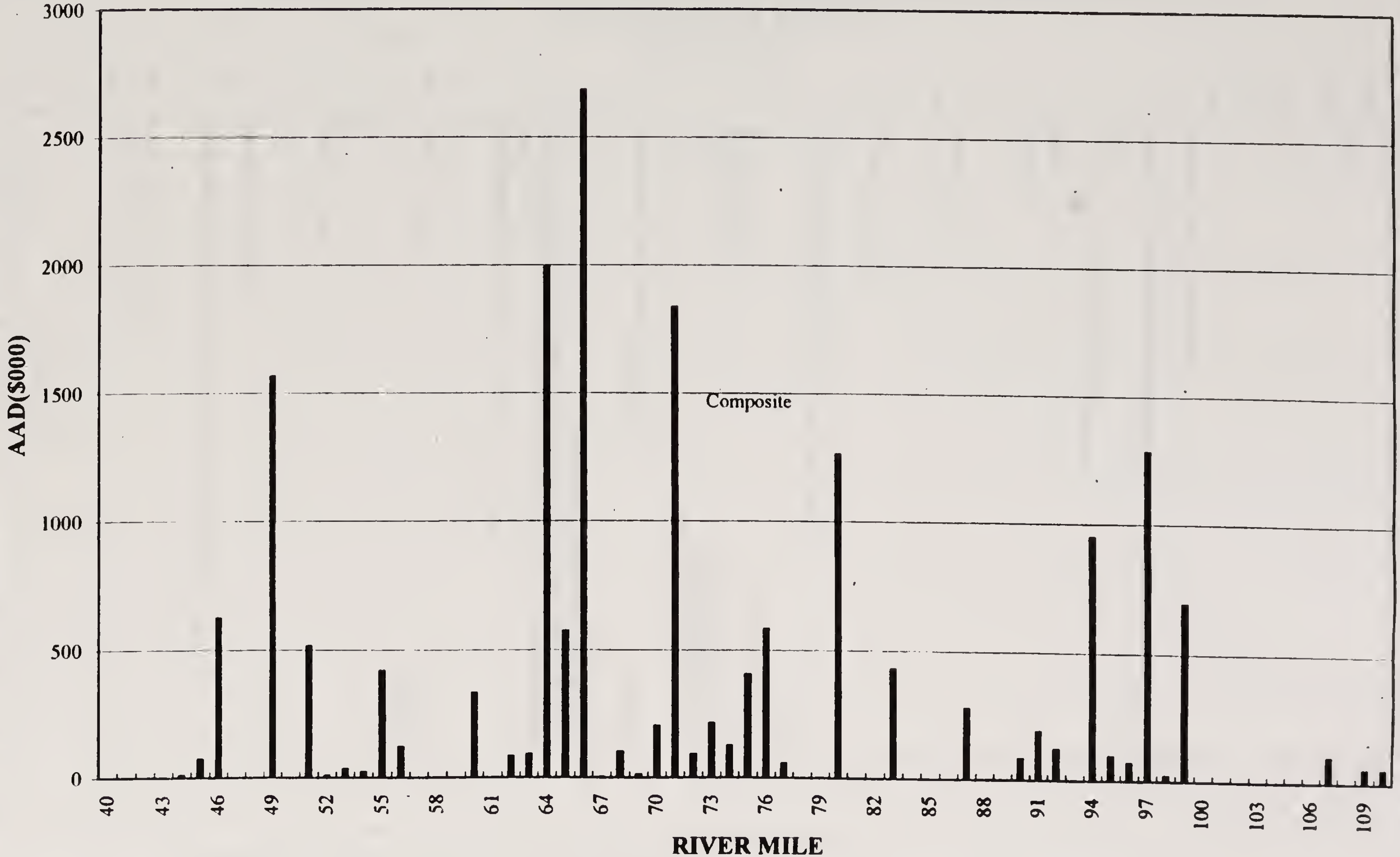


FIGURE 3 - UPPER DES PLAINES FEASIBILITY STUDY
TRAFFIC RELATED AAD ESTIMATE - 1995 FLOOD STAGE PROFILE

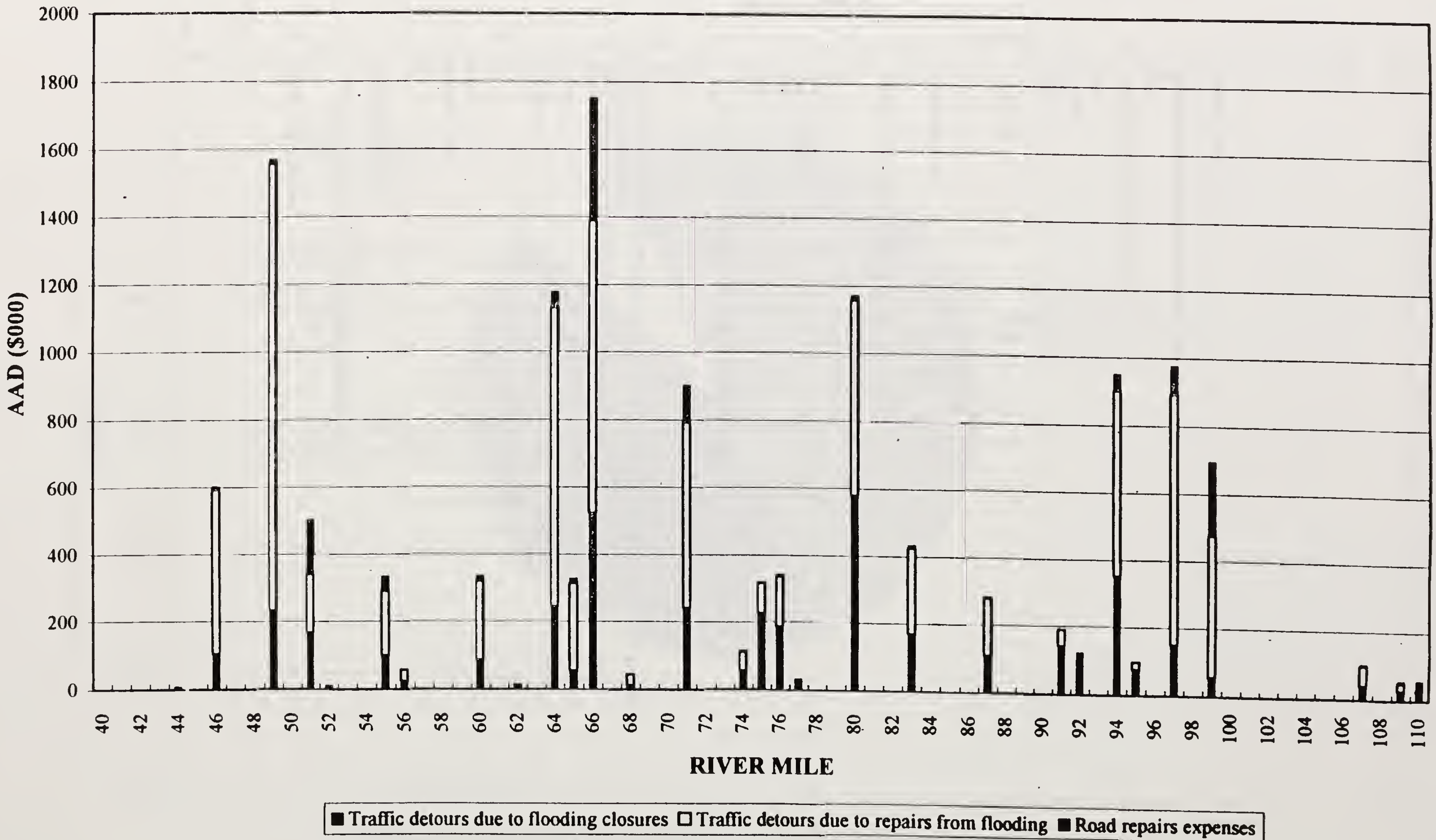


FIGURE 4 - UPPER DES PLAINES FEASIBILITY STUDY
COMMERCIAL/INDUSTRIAL/PUBLIC STRUCTURES AAD ESTIMATES - 1995
FLOOD STAGE PROFILE

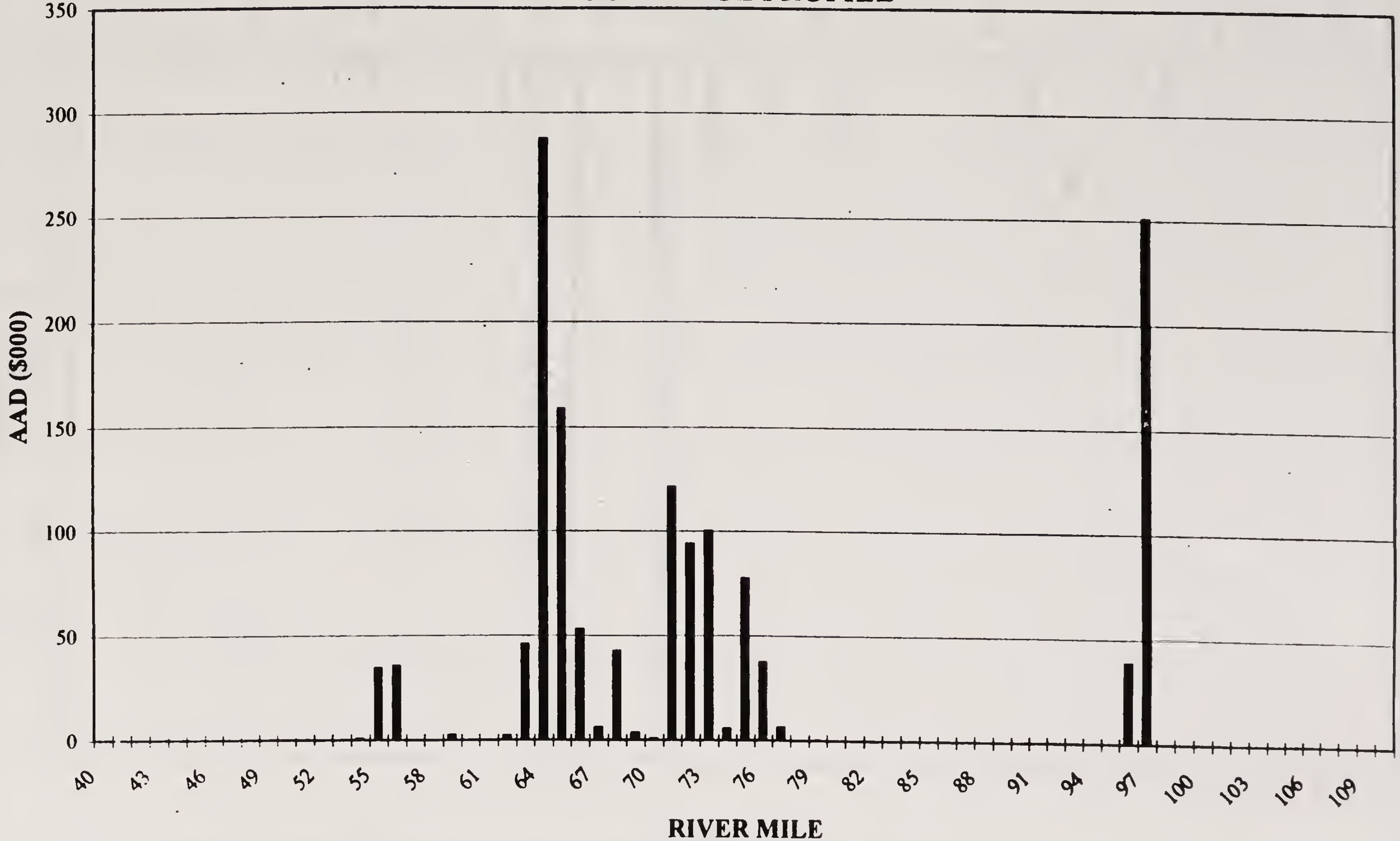


FIGURE 5 - UPPER DES PLAINES FEASIBILITY STUDY
RESIDENTIAL STRUCTURE AAD ESTIMATE - 1995 FLOOD STAGE PROFILE

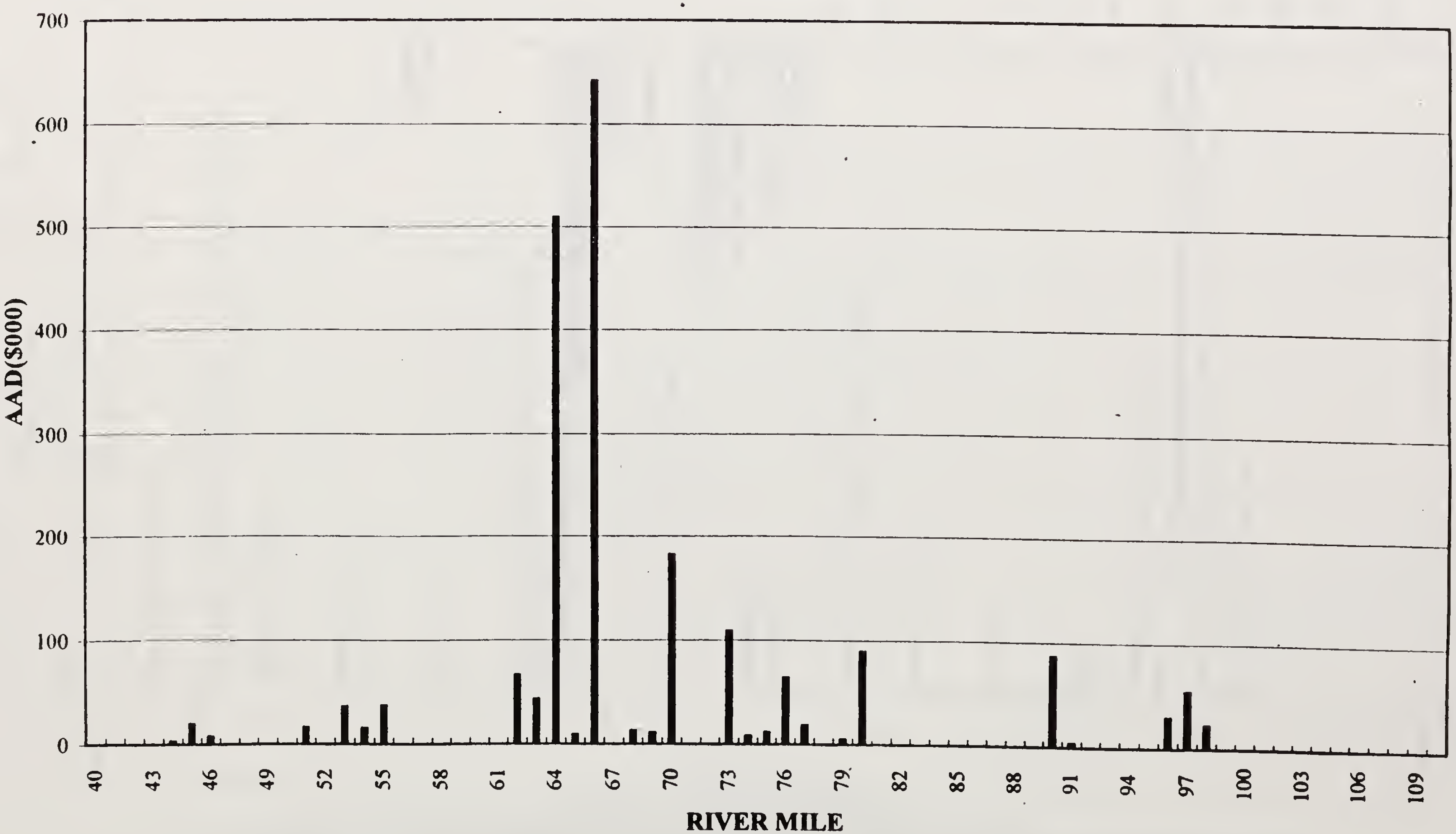


FIGURE 6 - UPPER DES PLAINES FEASIBILITY STUDY
APTS/CONDOS STRUCTURES AAD ESTIMATE - 1995 FLOOD STAGE PROFILE

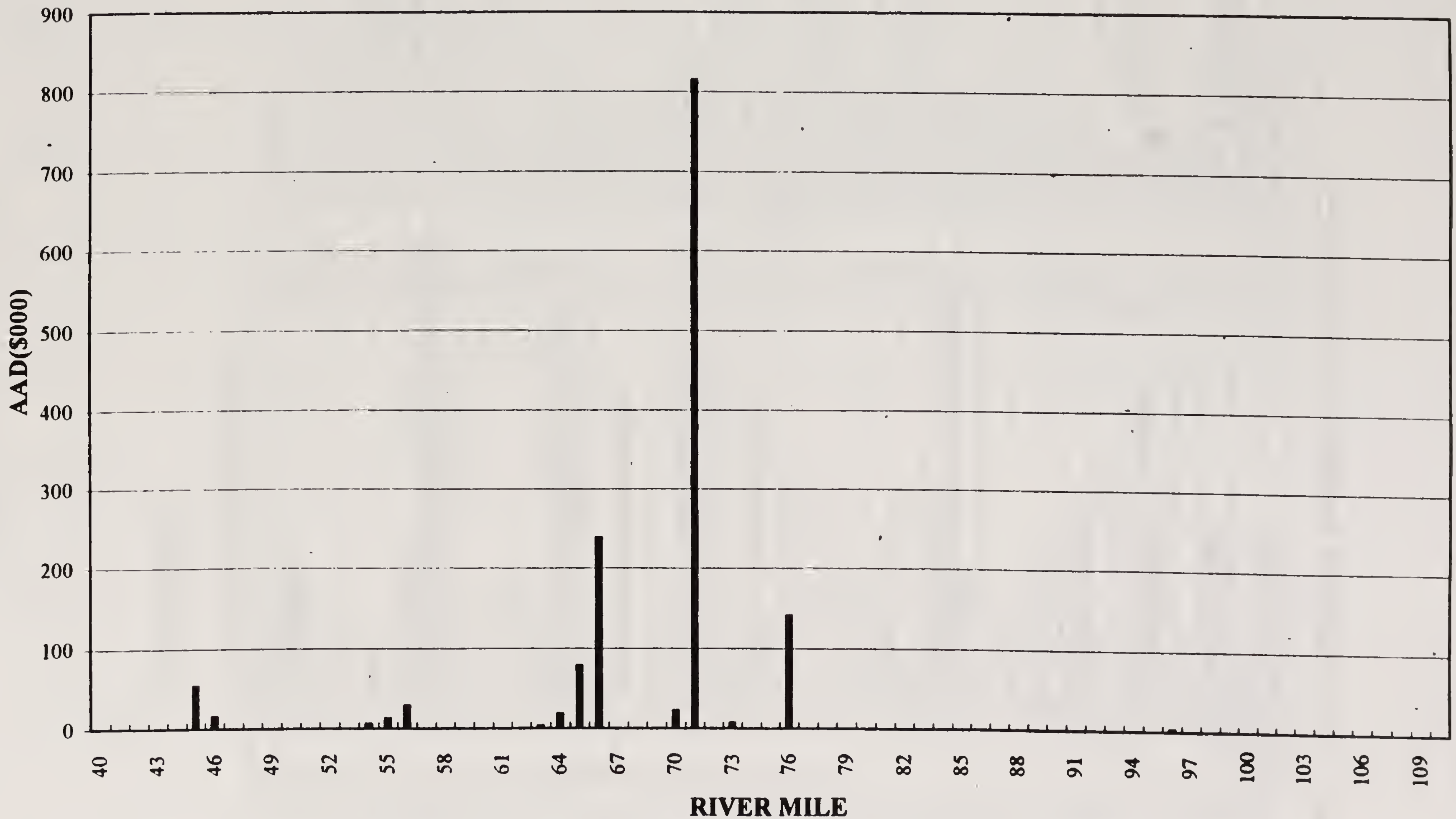


Table 5 - Road Crossings in Feasibility Report Study Area

River Mile	Road Name/Location	River Mile	Road Name/Location
44.44	Riverside	64.22	Algonquin Road
44.45	Crest of Hoffman Dam	64.77	Chicago & Northwestern RR
45.31	Salt Creek	64.80	Dempster Street
45.76	Burlington Northern RR	65.39	Rand Rd.
45.90	Forest Ave.	66.53	Chicago & Northwestern RR
46.40	31st Street	66.91	Golf Rd.
47.21	26th Street	68.00	Central Rd.
47.76	Illinois Central RR	69.30	Des Plaines
47.80	22nd Street	69.70	Lake-Euclid Ave.
49.00	Roosevelt Road	71.03	Milwaukee Ave.
49.25	Cemetery Bridge	71.72	Palatine Road
49.61	Eisenhower Expressway	74.34	Dundee Road
49.61	CA&E	75.50	Lake-Cook County Road
49.80	Remnants of CGW RR	76.75	Deerfield Road
50.21	Madison Street	80.20	Halfday Road
50.55	Washington Blvd. - IL 56	83.65	IL-60 (Townline Rd.)
51.00	Chicago & Northwestern RR	85.20	Elgin, Joliet & Eastern RR
51.04	Lake Street	87.30	Rockland Road
51.62	Chicago Ave.	87.80	Park Avenue
52.38	Milwaukee, St. Paul & Saulte St. Marie	88.19	C. M.St.P.&P. RR (Milwaukee Road)
52.91	North Ave.	88.40	Oak Spring Road
53.59	Bridle Path	91.11	Buckley Road
54.20	First Ave.	91.64	Unnamed #1
55.10	Grand Ave.	93.09	Unnamed #2
55.35	C. M.St.P.&P. RR (Milwaukee Road)	93.40	Unnamed #3
55.65	Belmont Ave.	94.50	Belvidere Road
56.92	Irving Park Ave.	95.20	I-94
57.92	Lawrence Ave.	95.95	Washington Ave. (Grange Hall Rd.)
59.59	O'Hare Access	97.11	Grand Ave. (IL-132)
59.60	CTA Rail Crossing	98.07	Skokie Hwy (IL-41)
59.63	Kennedy Expressway	100.50	Remnants of Footbridge #2
60.00	Higgins Rd.	100.60	Remnants of Footbridge #3
60.72	Devon Ave.	102.53	Townline Rd. (Footbridge)
62.00	Touhy Ave.	103.40	Wadsworth Road
62.60	Tri-State Tollway	107.10	IL-173
63.70	Oakton Street	109.59	Russell Road

FIGURE 7 BASELINE DAMAGES DERIVED THROUGH TRADITIONAL ECONOMICS VS. RISK AND UNCERTAINTY ANALYSIS BY RIVER MILE/REACH

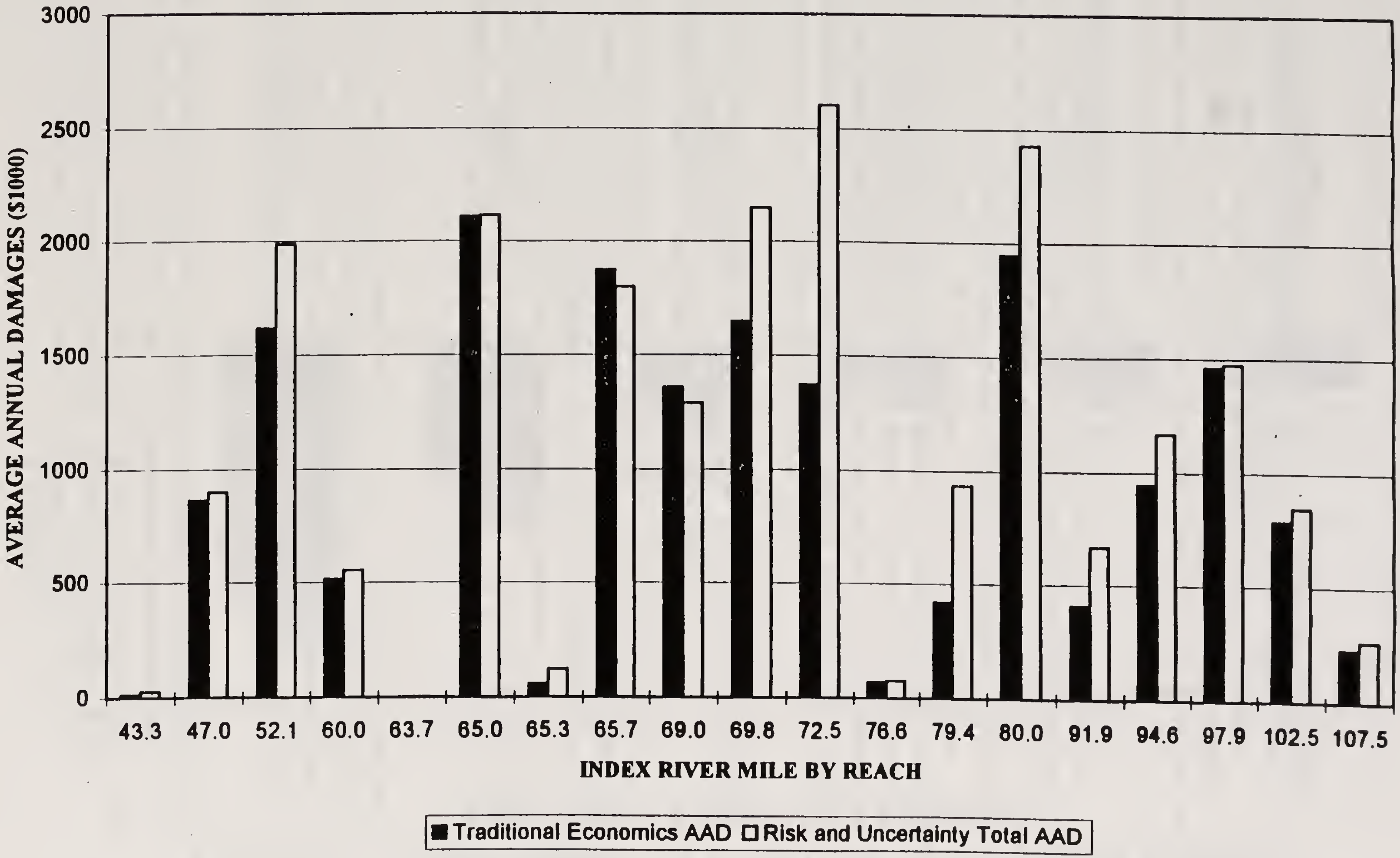
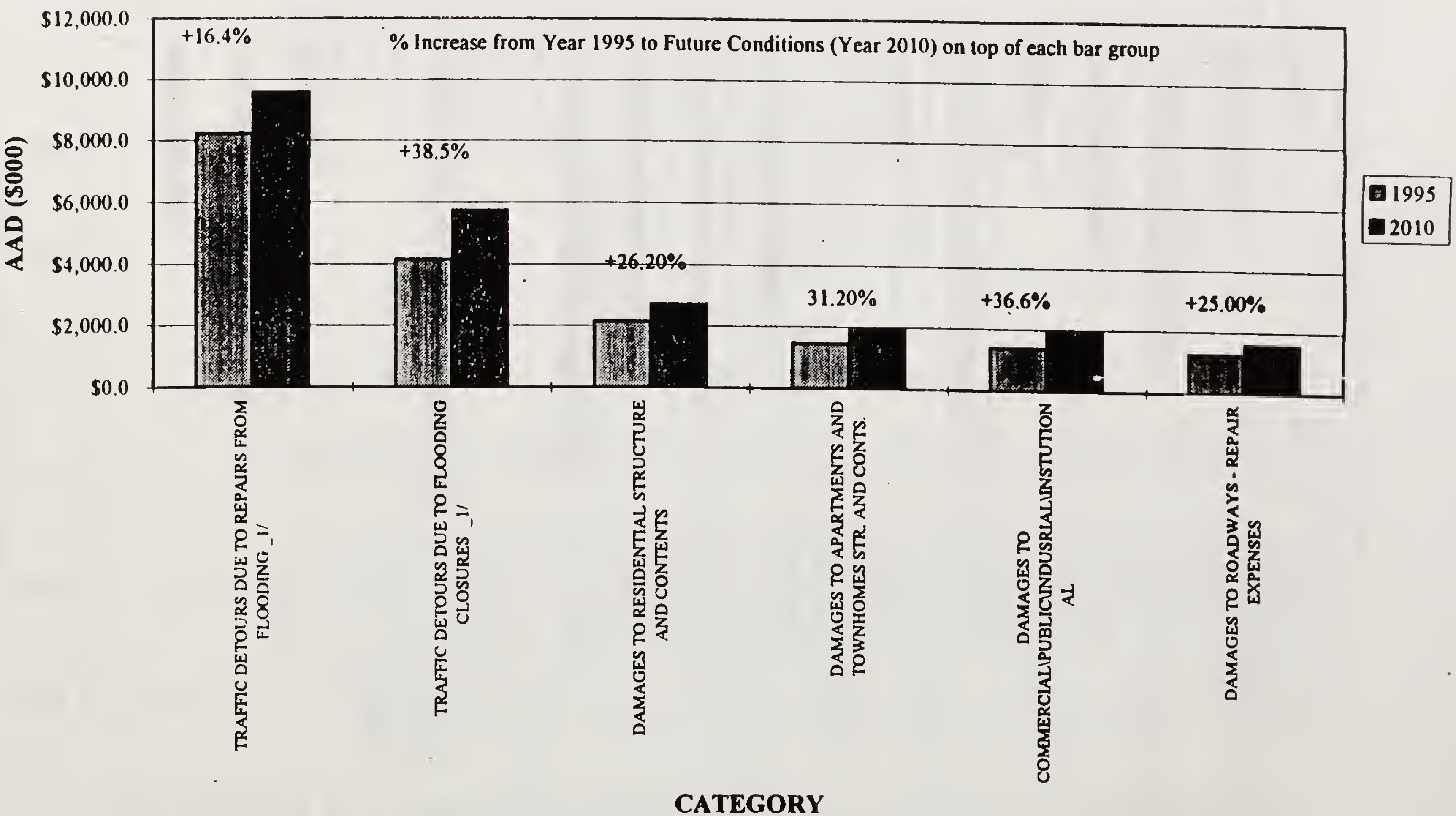


FIGURE 8 - COMPARISON OF BASELINE AND FUTURE DAMAGE LEVELS OVER SIX CATEGORIES



9. Assessment of Tributary Flood Damages

Although the primary focus of this study was on flooding on the mainstem Des Plaines River, previous investigations also established that significant flood damages exist on the tributary streams and creeks. Many of these flood damages will be and have been eliminated by locally planned flood control projects. Flood damages on some tributaries were not considered because the tributary did not meet the 10-year, 800 cfs (cubic feet per second) policy of the Corps of Engineers.

The 10-year, 800 cfs policy states that the Federal interest is limited to reaches of rivers which have ten-year flow rates greater than 800 cfs. Flooding problems on streams which have ten-year flow rates less than 800 cfs are considered to be a local drainage problem. However, in a flat, urban river basin, such as the Des Plaines River, tributaries with relatively low flows (less than 800 cfs for a 10 year event) may have significant, widespread flood damages. While, no plans were formulated for areas where the 10 year flow was less than 800 cfs, to be responsive to local sponsor concerns, tributary flood problems were investigated using information from previous studies. It was determined from these investigations, that most of the flood damage areas on the tributaries are along reaches that are upstream of the cutoff point for the 800 cfs policy.

The following paragraphs summarize the flooding problems on the major tributaries listed from north to south and how they were treated in this analysis:

Mill Creek: This tributary is located in northern Lake County. The confluence with the mainstem Des Plaines River is about one mile south of the Village of Wadsworth (river mile 103). Mill Creek is a major tributary at this point in the basin. Most of the Mill Creek sub-basin is agricultural and not highly developed. There currently is pressure to develop this sub-basin. There are no major flood problems in the sub-basin. The ten-year flow rates are 1,660 cfs at Dillys Road (Unincorporated Lake County Flood Insurance Study, FEMA, 1982).

Indian Creek: This tributary is located in southern Lake County. The confluence with the main stem is just south of Half Day Road (river mile 80). Land use is primarily agriculture and residential. The area is rapidly developing. There are no major flood damage areas in the Indian Creek sub-basin. The ten-year flood rate is 1,568 cfs at the confluence (FEMA, 1982).

Aptakisic Creek: This tributary is located in southern Lake County. The confluence is just north of Lake-Cook Road (river mile 68). Land use is agricultural, residential, and commercial and is becoming increasingly developed. The only known damage area on this tributary is the Parkwest area. This area is affected by backwater from the Des Plaines mainstem. The ten-year flow rate is 398 cfs near the confluence (FEMA, 1982).

Buffalo-Wheeling Creek: This tributary is located in southern Lake County and northern Cook County. The confluence is located just north of Palwaukee Airport (river mile 72). The area is primarily residential and is becoming more urbanized closer to the confluence. The downstream 3.1 miles of the creek is an excavated channel known as the Wheeling Drainage Ditch. There are five major damage areas along Buffalo-Wheeling Creek estimated to have $233,300 in average annual damages (1995 price levels). The ten-year flow rate is 1,130 cfs near the confluence (FEMA, 1983).

McDonald Creek: This tributary is located in northern Cook County. The confluence is about one mile north of Central Road (river mile 68). Land use is primarily residential with some commercial. The channel has been modified in the lower reaches. There are two major flood damage areas, near Camp McDonald Road and near Schoenbeck Road estimated to have $528,600 in average annual damages (1995 price levels). The ten-year flow rate at Camp McDonald Road is 644 cfs.

Weller Creek: This tributary is located in the City of Des Plaines and the Village of Mount Prospect. The confluence is near Rand Road (river mile 65). Land use is fully developed residential. The channel has been heavily modified and constrained. SCS mapping shows no areas of major overbank flooding for the 100-year event. The flood of 1987 caused overbank flooding of the creek and local ponding. This is attributable to the very intense localized nature of this storm. The ten-year flow rate is 700 cfs at the Chicago Northwestern Railroad Bridge. Another Chicago District project, the CUP O'Hare Reservoir, provides flood control for Weller Creek, due to the diversion of storm sewer flow from the Creek in to the reservoir.

Prairie-Farmers' Creek: This tributary is located in the City of Des Plaines. The confluence is just south of the Chicago and Northwestern Railroad tracks (river mile 64). The area is a mix of residential, commercial, and industrial land use. Most of the damages occur upstream of Potter's Road. The ten-year flow rate is 298 cfs at the confluence. The State of Illinois currently is proceeding with design and construction of local alternatives to reduce flood damages on this tributary. The State of Illinois Office of Water Resources has developed a plan to reduce flood damages from the Des Plaines River along this tributary that consists of a 100-year floodwall along Dempster Street and a berm/gate/pump station facility at Busse Highway and Farmers Creek. In this study this design is investigated as Levee site 50.

Willow-Higgins Creek: This tributary is located in the City of Des Plaines, O'Hare Airport area. The confluence is just south of Higgins Road (river mile 60). Land use is commercial-industrial with some residential areas. Average annual residual damages are estimated to be $47,700 (including $21,000 transportation damages, 1995 price levels). The ten-year flow rate is 1,055 cfs at River Road.

Crystal Creek: This tributary is located in the Schiller Park and O'Hare Airport area. The confluence is located south of Lawrence Avenue (river mile 58). Land use is residential and commercial. The creek is highly channelized and runs through several major culverts terminating in Lake O'Hare in O'Hare Airport. Average annual damages are estimated to be $113,200 (1995 price levels). The flooding problem on Crystal Creek is severe and a major concern of local and State officials. The creek received heavy damage during the 1987 flood. The ten-year flow rate is 145 cfs at 25th Avenue. In order to reduce some of the local damages along this tributary, the State of Illinois Office of Water Resources currently is proceeding with design and of several culverts, and channel improvements along the tributary.

Silver Creek: This tributary is located in Melrose Park and Franklin Park. The confluence is located south of North Avenue (river mile 52). Land use is mostly commercial and industrial. The creek terminates in Bensenville Ditch near O'Hare Airport. The creek is heavily channelized throughout its length. The NRCS recently constructed two flood control reservoirs: Structure 102 (500 acre-ft, Irving Park Road Reservoir) and Structure 106 (245 acre-ft, Franklin Park Reservoir). Residual average annual damages are estimated to be $190,800 (1995 price levels). The major flood damage area is in Franklin Park. The ten-year flow rate at Armitage Avenue is 203 cfs with the NRCS projects in place.

B. SUMMARY OF IDENTIFIED PROBLEMS AND OPPORTUNITIES

Data collection and analysis of the Upper Des Plaines River for existing, baseline and future conditions provided sufficient information to determine the extent of existing flood damages in the study area. In addition, the development of analysis tools (the hydrologic, hydraulic and economic models) provided a means for evaluation of the magnitude of the current flood damages, as well as a means to evaluate the effectiveness of proposed flood damage reduction alternatives. The formulation and analysis of flood damage reduction alternatives is discussed in the next two sections.

IV. PRELIMINARY FORMULATION OF ALTERNATIVE PLANS

A. PLANNING OBJECTIVES AND CRITERIA

The procedures for conceiving, developing, and evaluating the feasibility of project plans are outlined in the Water Resource Council's "Economic and Environmental Principles and Guidelines for Water and Related Land Resources Implementation Studies" (Principles and Guidelines - P&G) approved by the President in February 1983 and in various Corps of Engineers' regulations and guidance. The approach deals with identification and evaluation of all reasonable alternatives that would alleviate flooding in a community. The amount of effort involved is constrained by the national objective, as well as the technical, institutional, economic, and environmental feasibility of the various plans considered.

1. National Objective

Under the Principles and Guidelines, the Federal Planning objective is to contribute to national economic development consistent with protecting the Nation's environment pursuant to national environmental statutes, applicable executive orders and other Federal planning requirements. Contributions to national economic development (NED) are increases in the net value of the national output of goods and services expressed in monetary units and economic efficiency. Water and related land resources project plans are to be formulated to alleviate problems and take advantage of opportunities in ways that contribute to this objective.

2. State and Local Objectives

State and local objectives considered in the planning process were provided by the project local sponsors, the State of Illinois, the Metropolitan Water Reclamation District and Lake County Stormwater Management Commission. These objectives, like those of the Corps of Engineers, are based on their missions and functions.

State of Illinois Objectives

The Office of Water Resources' primary objective is to provide flood damage protection for the residents of the State. This responsibility is carried out through a permit program for construction activities in the floodplains, a capital construction program for urban flood control projects, and technical assistance and information provided to local officials and floodplain residents.

In the Des Plaines River Study, the Office of Water Resources sought to identify existing flood damages; address the flood problems on a regional basis; evaluate alternatives

for mitigation of flood damages; and provide for local and private input to the study process and alternative evaluation. An additional study objective was to provide updated floodplain mapping and regulatory models using multi-use modeling for future planning along the mainstem and its tributaries. Throughout the study, the level of Federal interest in flood damage mitigation within the Des Plaines River watershed also must be identified.

Metropolitan Water Reclamation District Objectives

The Metropolitan Water Reclamation District's objectives include the development of a program of structural and non-structural measures that will minimize or eliminate overbank flooding damages along the Des Plaines River and along the tributaries of Crystal Creek, Prairie Farmers Creek, and other tributaries of the Des Plaines River whose floodplain coexists with the mainstem. In addition their objectives include: reduction of flood damages from storm sewer outlet submergence; the preservation and enhancement of the quality of life along the river; the enhancement of the environment along the river; and the development of flooding solutions compatible with and which enhance the existing and proposed flood control plans of other agencies.

Lake County Stormwater Management Commission Objectives

The Lake County Stormwater Management Commission's (LCSMC) role in the Des Plaines River Flood Control Feasibility Study was to facilitate local community input into the planning process. In this role, the Commission funded a small portion of the study, provided mapping and data to the Corps, and assisted in consensus building among the stakeholders toward a locally-supportable plan.

The Commission's objectives are to ensure a comprehensive, watershed-based approach to plan development and implementation. The authorized plan will represent an effective balance between various public interests including: flood damage reduction, surface water quality, floodplain management, natural resource protection and enhancement, open space aesthetics, and multiple community benefits from structural solutions.

3. Specific Corps of Engineers' Criteria

Technical Criteria

Technical criteria to be used in designing the alternative plans of improvement are based on Corps of Engineers design standards for flood damage reduction. Applicable criteria are summarized as follows:

- The level of protection should provide maximum effectiveness, safety, and security with consideration of potential catastrophic events.
- Flood damage reduction would be provided by easily operated flood protection facilities.
- Flood protection provided within the study area would not result in increased flood levels in other portions of the river basin.
- Interior flood control facilities would provide protection against interior flooding coincident with high river stages.

Institutional Criteria

The institutional constraints include: availability of real estate, acceptability of the plan to the residents and local sponsor, and the financial capability of the local sponsor. Thus, any solution that would require implausible changes in the existing institutional framework should be eliminated. In addition, every effort should be made to involve local governments in the plan formulation and evaluation process. Failure to do so could significantly compromise the prospects of implementing a plan.

Economic Criteria

Economic criteria used in evaluating each alternative plan include the following:

- Tangible benefits must exceed project costs. Annual costs and benefits are based on an interest rate of 6-7/8 percent and October 1998 price. A 50-year amortization period is used for all features considered.
- The scope of the proposed project elements must be optimized to provide maximum net benefits.
- No more economical means, evaluated on a comparable basis, which would accomplish the same purpose(s) would be precluded from development if the plan were undertaken.

This limitation applies only to those alternative facilities that would be physically displaced or economically precluded from development if the project were undertaken.

- The plan must fit integrally into an overall plan for water and related land resource management and development within the Des Plaines River basin.

The benefits attributable to any alternative plan are determined by comparing the conditions without a project to that with a project. Project benefits are the damages which are prevented by implementation of a project. The project costs include the cost of initial design and construction, lands and damages, the cost of mitigation, interest during construction, and future operation and maintenance. Both benefits and costs are annualized over the project life and each project element must be justified incrementally.

Environmental Criteria

The primary objective of environmental criteria is to ensure a long-term balance between humans and their environment. The environmental quality of the study area should be protected, preserved and, if possible, enhanced with the selected project. Special consideration should be given to protecting and preserving riparian and wetland habitats and water quality. Alternatives are to be evaluated to determine their effects on ecosystems both within and adjacent to the study area. A project should not cause significant residual adverse impacts to the environment. Evaluation of environmental impacts accounts for the non-monetary effects of a plan on the ecological, cultural, and aesthetic attributes of significant natural and cultural resources. Environmental impacts also account for the social effects of a plan such as recreational opportunity and health and safety. If adverse impacts due to implementation of the project are unavoidable, mitigation may be required.

B. PRELIMINARY SCREENING

To reflect the national objective as well as those goals more specific to local, state, and/or regional interests planning goals specific to the Upper Des Plaines River basin are defined as follows:

- Reduce flood damages in the Upper Des Plaines River basin.

- Protect and enhance the natural, cultural, and ecological resources within the project area and mitigate project-induced impacts on these resources.

- Maintain or enhance the social well being of the communities to the maximum extent possible.

- Minimize impacts of the project on surrounding communities.

Reference was made to previous studies performed by the Corps of Engineers, the Soil Conservation Service, the State of Illinois, the Metropolitan Water Reclamation District of Greater Chicago, and other local agencies. A wide range of flood damage reduction measures were evaluated to identify several specific courses of action including the no-action alternative. Alternatives that were not eliminated in the preliminary screening were carried over to the final plan formulation phase.

1. No-Action Alternative

Under the No-Action alternative, the Corps of Engineers will not participate in efforts to provide additional flood protection in the study area. The local governments will be left with the responsibility of providing protection against Des Plaines River flooding. The No Action alternative will have a negative significant impact upon national or regional economic development, and it will not resolve the current flood threat and potential threat for catastrophic flood damages approximately $25,300,000 in average annual damages (for the mainstem Upper Des Plaines River based on without project baseline conditions).

2. Structural Damage Reduction Alternatives

Structural measures are a direct means of flood protection. They can either hold back waters, such as through the use of a levee or floodwall, or lower the water surface elevation using channel modification, detention, or diversion of floodwaters. The following are examples of structural damage reduction measures investigated in this study: Off-line and in-line reservoirs, channel modifications, diversions, bridge modifications, dam modifications, levees and floodwalls, lateral storage areas, and road raises. The detailed evaluation/formulation associated with each of the structural damage reduction alternatives evaluated is contained in Appendix J, Plan Formulation.

3. Nonstructural Damage Reduction Alternatives

Nonstructural measures are passive flood protection alternatives that do not alter surface inundation patterns but reduce existing damages and reduce future damage potential. Examples include: floodplain management, flood emergency preparedness and flood warning plans, various flood proofing changes to buildings or lots, acquisition and demolition, and relocation of structures in a floodplain. These measures can be used alone or in combination with other nonstructural or structural measures to reduce flood damages. The measures are described in Appendix J, Plan Formulation.

4. Summary of Preliminary Plan Formulation

Table 6 contains a synopsis of the plan formulation analysis for each of the structural flood damage reduction alternatives briefly described above. Preliminary costs (without real

estate) were developed for each of the alternatives evaluated. The cost were developed to serve as an additional screening tool, and for input into the optimization modeling. The costs of nonstructural options are listed in Table 7 on a per residence/structure basis based on costs developed in the Reconnaissance Report and in the Chicago District's Little Calumet River, Indiana Final Design Memorandum and converted to 1998 dollars. Additional information regarding both the structural and non-structural alternatives investigated is contained in Appendix J, Plan Formulation.

Table 6 - Structural Alternative First Costs

Feature	Cost Range [1] ($1M)	Remarks
Reservoirs	$1 - 23	Site and storage volume specific.
Levees and Floodwalls	$1 - 6	Site specific, real estate costs significant, potential for adverse stage impacts. Effective against overbank flooding up to design level of protection.
Lateral Storage Areas	$0.3 - 1	Less expensive than reservoirs because natural storage is used instead of excavating, and gravity drainage is utilized instead of pumping.
Road Raises	$0.1 - 7.5	Method too expensive due to transportation damages. In most cases, immediate transportation delay costs during construction alone would be nearly enough to offset long-term annualized transportation delay savings. When coupled with construction costs, total costs would be too great for feasibility.
Channel Modification	N/A	Extensive dredging required to be effective. Cost prohibitive for the Des Plaines due to limited change in channel slopes.
Diversions	N/A	TARP diversion investigated
Bridge Modifications	N/A	Method too expensive when w/transportation damages due to delays are included in the costs.
Dam Modifications	N/A	Effectiveness of dam modification limited to small reaches.

[1] Includes contingencies, engineering and design, and construction management costs.

Table 7 - Nonstructural Alternative First Costs

Method	Cost (Price Level – October 1998)
Utility Relocation	$ 13,000
Raising	$ 51,700
Brick Veneer	$ 21,200
Berm/Floodwalls	$ 16,300
Relocation	$ 130,300

Based on the results of the preliminary plan screening process, it was determined that further evaluation of excavated reservoirs as flood water storage sites, possibly in combination with levees and/or floodwalls, lateral storage areas, and nonstructural alternatives should be pursued. Plan formulation of the Preliminary Corps Plan was initiated.

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V. FORMULATION OF THE PRELIMINARY CORPS PLAN AND LOCALLY PREFERRED PLAN

A. ADDITIONAL PLAN FORMULATION

Based on the initial plan formulation, it was determined that flood detention storage and localized flood protection would be evaluated in the final plan formulation phase. Additionally, non-structural features would also be included in the final evaluation. Separate screening/evaluation techniques were used for each of the three major categories of potential alternatives.

A number of flood detention storage sites were selected for evaluation. Following the analysis of the storage sites, other structural solutions, i.e. levees and floodwalls were evaluated for those locations where significant residual damages remained after implementation of the flood storage plan. Finally, non-structural flood damage reduction alternatives were analyzed for inclusion in the final array of alternatives. The results of the analysis of various flood damage alternatives is discussed in the following sections and in Appendix J, Plan Formulation.

1. Evaluation of Flood Storage Alternatives

Due to the size of the watershed, the complexity of the system, and the large number of potential flood control alternatives, it was determined to employ an optimization model to evaluate the large number of storage alternatives remaining after the first phase of plan formulation. At the beginning of plan formulation there were approximately 53 potential reservoir sites to evaluate. After the initial plan formulation screening, 32 sites remained for further evaluation. 21 sites were eliminated based on economics and/or engineering feasibility.

For this stage of analysis, the MULTIPLAN optimization routine of HEC-1 was selected. The MULTIPLAN optimization routine of HEC-1 evaluates and optimizes each storage site, as well as the combination of storage sites to produce an optimized storage plan, thus producing a comprehensive analysis of the flood control alternatives throughout the watershed. The Hydrologic Engineering Center of the Army Corps of Engineers (HEC) was contracted to assist the Chicago District in utilizing the HEC-1 optimization routine for the final alternative plan formulation. Additional details on the development and use of the HEC-1 MULTIPLAN are contained in Appendix A, Hydrology and Hydraulics.

Optimization Data Requirements

Capital costs for detention were based on general cost curves for previously constructed off-line and on-line storage sites. The curves were developed from construction costs based on recent Chicago District construction projects and recent Office of Water Resources construction projects. At this point in the analysis, real estate costs had been obtained for only two sites. In order to utilize the cost curves developed, and to keep costs and benefits comparable, no real estate costs were included in the HEC-1 optimization model. It was deemed unreasonable to develop refined real estate or construction estimates given the number of sites being analyzed at this point in the formulation. A discount rate of 8% was assumed. Annual Operations and Maintenance costs, based on previous District projects, were assumed at this point to be 0.64% of capital costs.

As discussed in the previous section, baseline economic damages were developed along 26 damage reaches on the mainstem Des Plaines River. These damages were further defined for inclusion in the HEC-1 MULTIPLAN model. For each damage reach a frequency-discharge-stage-damage relationship was defined at an index point. Baseline damages by frequency event were aggregated between the upstream and downstream river miles of each reach and linked to a stage-frequency relationship at the index point for that particular reach.

In addition to the preliminary costs and baseline economics, the MULTIPLAN optimization utilized the without-project baseline conditions hydrologic modeling previously described.

MULTIPLAN Analysis

During the initial MULTIPLAN analysis, thirty-two off-line reservoir sites, two reservoir expansion sites, and two in-line detention sites were modeled and optimized individually. The HEC-1 optimization model utilized a two-plan damage analysis, a pre-project (baseline condition) and a post-project. Utilizing the flood control cost data, including capital cost and annual operation and maintenance, the MULTIPLAN model produced benefits and costs for the project being analyzed. Then, a comparison to baseline, without project conditions could be made. The optimization model determined a maximum net benefit for a flood control project consisting of one or more flood control alternatives. The model determined an optimal flood control system by minimizing the objective function (the sum of a flood control system's total annual cost and the expected annual damage occurring in the basin.)

The minimization of objective function resulted in the maximization of the net benefits accrued due to the flood control system. Net benefits are equal to the difference between the expected annual damage (EAD) occurring for the baseline condition and the sum of the flood control system costs and EAD occurring for the with project condition. Analysis of

off-line reservoir sites was made assuming the flow was diverted at a specified rate (several rates were examined). Favorable reservoir sites were optimized in groups and prioritized based on those having the greatest positive net benefits. The optimization modeling tested different combinations of volumes and diversion rates at each site considered.

The remaining detention sites with the greatest net benefits were combined and optimized in a variety of plans to determine the optimized reservoir plans with the greatest net benefits. The sites were prioritized based on consideration of net benefits, benefit-cost ratios, and percent damage reduced. Four plans containing flood water storage projects were developed and analyzed.

Finally, the optimized system was evaluated in greater detail again using the HEC-1 optimization model, but with updated economics, construction costs and including real estate costs. Construction and Real Estate costs were developed for each specific site. (Real estate costs were not included in the preliminary screening analysis, as previously noted). In addition four sites were re-tested after revised cost estimates were developed. The HEC-1 and HEC-2 detailed modeling was then run for the final array of storage sites in order to develop the basis for a preliminary benefit-cost ratios of each project element.

The final array of storage sites developed from the HEC-1 MULTIPLAN optimization simulations were 12 flood storage sites: five off-line reservoirs, two reservoir expansions, and five lateral storage areas. The results of the optimization analysis are listed in Table 8 below.

Table 8 - Results of MULTIPLAN Storage Optimization Analysis

Storage Element	Location	Optimized Volume (acre-feet)
Reservoir V	Lake County	4,608
Reservoir 14a	Lake County	1,000
Reservoir 17a	Lake County	247
Reservoir 18a	Lake County	306
Buffalo Creek Reservoir	Lake County	500
Reservoir CC1	Cook County	335
Reservoir CC3 (Big Bend)	Cook County	587
LSA B1	Lake County	640
LSA B3a	Lake County	546
LSA B4a	Lake County	533
LSA B6	Lake County	650
LSA B10	Cook County	241

2. Analysis of Levee/Floodwall Alternatives

Levee/floodwalls flood damage alternatives were considered for those locations where residual damages remained after implementation of the optimized storage plan. Based on a screening of the levee locations identified in the Reconnaissance Report, levees with potential benefit-cost ratios greater than 0.5 were re-evaluated in this study (7 levee locations). An additional levee site was suggested for evaluation by the Office of Water Resources. After the development of preliminary designs and costs, three locations were eliminated based on an preliminary benefit-cost analysis.

The heights of the levees units were optimized using the results of the risk simulations performed by HEC under contract to the District. The levee features were optimized without the storage alternatives. The HEC analysis developed a relationship between levee heights at each of the five locations versus damages prevented, for five levee elevations tagged to five different return frequency stages. Additional details on the HEC analysis is contained in Attachment 3, Appendix A.

3. Non-Structural Analysis

Five types of non-structural measures were considered: demolition/evacuation/ relocation; structure raising; construction of small berms; window closures/brick veneer; and utility raising. A site by site analysis is provided in Appendix J, Attachment 2. The locations of each site drawn on a USGS 7.5' quad map is provided in Appendix J, Attachment 2. The technical, economic, and social impact evaluations are detailed in Appendix J, Attachment 3.

Demolitions and evacuations/relocations are effective measures for the reduction of floodplain damages, however, ones that are rarely employed by the Corps in a Federally recommended project. This is due to the requirement for each element of a Federal project to be incrementally justified. Because removal of the structures from the floodplain eliminates future damage reduction, often these non-structural measures are not economically feasible. Preliminary evaluations indicated that demolitions and evacuation/relocations were not feasibile for this project.

Structure raising, which is a method to elevate the damage areas above the level of the 100 year flood may be warranted in some cases. During the Reconnaissance Study, it was determined that structural modifications might be feasible for six apartment buildings located at RM 65.3 (near Dempster Street in Des Plaines). However, a more detailed review of the structures and the extreme costs involved with raising multiple unit buildings clearly established that this plan was economically infeasible.

Construction of earthen berms is another measure that may be feasible in certain applications. However, there is no conceptual difference between a berm and a levee, particularly for a Federally authorized project. Based upon the Reconnaissance stage of the analysis, a few groups of homes in the study area appeared potentially feasible. However, a detailed analysis of potential levee sites was evaluated in this feasibility study, and none of these considered levee/berm sites turned out to be economically feasible.

Utility relocations are often warranted when basement flooding caused by sewer backup is a major problem, as it involves raising all flood damageable utilities/connections above expected damage levels. Where basement flooding is a problem, it nearly always occurs much more often than does overbank flooding. However, it should be in the local property owners' interest to make this adjustment, if warranted, whether or not there is an authorized Federal project. Therefore, the District does not consider this measure to be a valid portion of the proposed Federal project, even though the measure itself may be warranted in some cases.

The last considered measure is door/window closures/brick veneer. This measure can sometimes be effective as a last resort, but its feasibility depends upon a number of factors, that must be considered for each structure, one of the most important being the structural condition of each building. Social factors, including the willingness, ability, and dependability of each individual property owner to make necessary closures for each flood event are very problematical. Flood damages from one flood event in which the closures are not properly made in a timely manner would likely invalidate the economic feasibility on which construction of the measure was based. In the Reconnaissance level report, only one group of homes qualified as potentially acceptable for this plan, and then only marginally so. Inclusion of the full array of costs necessary to validate this form of non-structural protection rendered this area economically infeasible as well.

Based on the analysis for each non-structural method described above, it appears that none of the non-structural methods can be recommended for implementation due to their lack of economic justification. Non-structural methods were not carried forward in the development of the Preliminary Corps Plan.

4. Detailed Design Considerations for Structural Components

Once the potential components of the Preliminary Corps Plan had been identified, design criteria were developed for each feature type. The criteria were developed based on a number of factors: engineering regulations and manuals, previously constructed Chicago District projects, as well as site specific constraints related to each individual component. A description of the general features for each type of structure is described in the following paragraphs. The general features were applied to the site-specific designs developed in the Preliminary Corps Plan, and were applied to the Locally Preferred Plan components.

Off-Line Reservoirs

An off-line reservoir is a excavated flood storage area that is not directly connected to the river, but it utilized during flood events via an inlet structure. Water is evacuated after a flood event usually by pumping from the storage area into the river. A system of excavated floodwater reservoirs acts to reduce flooding by capturing some flood flows in excess of a selected flow rate that is ideally just below that at which downstream flood damage occurs. The diversion and inlet structures to each reservoir are designed so that for normal low flow conditions, no flow is diverted into the reservoirs. When flow rates increase to the point at which overbank flooding could cause damages, a portion of the flow is diverted into the reservoir. The diverted floodwater is temporarily retained during the flood event and returned to the channel by a pumping station after water in the main channel reaches a low flow condition. The design bypass flow is low enough so that only minimal overbank flooding results from this flow rate. The flood damage reduction effect is greatest immediately downstream from each reservoir. Further downstream, flow rates increase due to local runoff and tributary contributions and some overbank flooding may occur, although not to as great an extent as without the project.

The excavated reservoirs were designed similar to those designed by the Chicago District for the North Branch of the Chicago River. The storage is excavated below the elevation of the floodplain to store floodwater in excess of that conveyed downstream beyond the inlet weir structure. The reservoirs as formulated would be approximately 40 feet deep and have side slopes of 4 Horizontal to 1 Vertical or flatter. Any fill material, from excavated material or construction, placed between the existing ground elevation and the 100-year water surface elevation was subtracted from storage computed in the reservoir excavation. It is assumed that during the next phase of the study, the local sponsor(s) may request modifications to the basic Corps design.

A portion of the reservoir bottom would consist of a permanent pool for the accumulation of sediment over the 100-year design life of the reservoir. These sediment pools would be approximately 5 feet deep, and the volume of these pools would not included in the flood storage computation.

The inlet structure would be a single structure or a system of structures used to convey the excess flow into the reservoir. The inlet structure could be a single spillway, to dampen the energy of the incoming flow, or a structural system consisting of a straight drop spillway, a transition section, and a straight inlet chute. The pumping plants would consist of multiple, vertical turbine pumps. Pumps would be used to evacuate the floodwater from each excavated storage reservoir. These pumps would have a capacity to provide drawdown of the reservoir to the level of the permanent pool in approximately 6 days or less. The pumping plants would be suitably housed for protection of their equipment and for maintenance. The pumping plants could be operated automatically by reservoir stage gages with automatic shut down override controls from the downstream channel gaging points. Manual operation would also be possible.

Seepage of groundwater into the reservoirs through the granular materials is one of the major concerns in such areas with generally high groundwater levels and within close proximity to the river. Based on available geotechnical information, a majority of the reservoir areas are underlain by various kinds of granular soils. The groundwater table is at a depth of 0 to 17.5 feet below existing ground surface. Depth of excavation to develop the reservoirs ranges from 35 to 40 feet. The nearest distance of the Des Plaines river from the top and bottom edges of excavation generally ranges from about 80 to 530 feet. A slurry wall behind the outer boundary of the reservoir and/or clay liner on the slope and the bottom of the reservoir will cutoff the groundwater seepage into the reservoir and also increase the stability of the slopes. The clay liner in conjunction with seeding will also ensure slope protection against surface erosion due to precipitation. To minimize any possibility of heaving of the bottom of the reservoir, the slurry wall will be extended to an assumed maximum depth of 10 feet below the bottom. Further details on this analysis are available in Appendix D, Geotechnical Engineering.

In-Line Reservoirs

An in-line reservoir is constructed by building a dam across the channel. The dam would consist of an earthen dam, low-flow culvert(s), concrete spillway, and emergency spillway. The presence of the dam acts to retain floodwaters in this flood storage zone that would typically pass downstream. The low-flow outlets were sized to pass the normal low flow without significantly increasing stages. Elevations of the primary spillway were based on both elevations of nearby structures (e.g., houses, top of road elevations) and the extent of areal inundation. Elevations and lengths of emergency spillways were based on passing PMP flows without a significant build up of head. Flood storage is gained between the elevation of the low flow culvert(s) and the primary spillway.

Earthen Levees

An earthen levee is a designed barrier to flooding constructed of impervious material in the core to minimize seepage through the structure. The core material is covered with topsoil and seeded with grasses and other plantings that will provide stability to the earthen surface of the levee. To minimize the possibility of developing transverse cracking, all levees will be constructed with a minimum slope of 2.5 Horizontal to 1 Vertical side slopes or flatter. The core will be constructed of compacted clays that meet specified density and compaction requirements.

All levees over 6 feet in height will have 10 foot crest width. The height of the 8-foot crest width levees does not exceed 6 feet. Levees with 5-foot crest width are under 2.2 feet high. Most of these smaller levees (maximum height 2.2 feet) protect fairly small areas, and as such extend between 400 and 500 feet. The landward slope of 5-foot high levees will be regraded with gentler slope to meet existing grades, wherever possible. For 8- and 5-foot high levees, access to the levees for floodfighting, inspection, and maintenance will either be provided by a 10-foot permanent real estate easement along the landward levee toe or

locating the levee immediately parallel to an existing road. Erosion protection will be placed along the toe of levee segments that are adjacent to the river. More detailed information on this analysis can be found in Appendix D, Geotechnical Engineering. A request for waiver on the 10-foot crest width policy was submitted to HQUSACE in July 1996 and was accepted in August 1996.

Typical levee riprap protection and typical toe drains are shown on Plate 3. Typical levee cross sections are shown on Plate 4. A standard levee section with 2.5 Horizontal to 1 Vertical side slopes was designed for all sites., Full design descriptions are presented in Appendix B, Civil Design and a discussion of geotechnical concerns is in Appendix D, Geotechnical Engineering.

Concrete Floodwalls

Floodwalls were designed for areas in which there was not enough real estate or physical space available to accommodate a levee. When a floodwall and a levee intersected, the floodwall is usually embedded into the levee section for approximately 10 feet. This minimizes the potential for failure of the line of protection at the floodwall/levee junction. No structural analysis was performed on any of the floodwalls in this study. This analysis will need to performed in the next phase of this project. However, design considerations needed to develop cost estimates for floodwall components were based on actual designs and construction bid prices for floodwalls constructed as part of the Chicago District's Little Calumet River, Indiana Flood Damage Reduction Project. A typical floodwall cross section is shown on Plate 5.

Closure Structures

Closure structures are required to be installed across all roadways that intersect a levee in order to form a continuous line of protection. All potential closure structures in this study are sandbag type closure structures because the required elevation is below or equal to three feet. Sandbag closures are usually recommended when the closure height is less than 3.5 feet, which is the maximum recommended construction height. Sandbag closures are installed across the roadway and butted up against the levee or floodwall. Usually, the bag structure is covered with plastic to increase the capability of the structure to hold back floodwaters. A typical sandbag closure is shown on Plate 6. The District also considered alternate closure methods, specifically road raises in order to eliminate or minimize sandbag closures. Eliminating or minimizing closure structure sizes in turn minimizes the risk associated with the operation of the flood control project.

Interior Flood Control

A levee or floodwall system is designed to prevent overland flooding from inundating protected areas up to the elevation of the levee crest. Levee system designs must include provisions for evacuating upland or interior runoff from behind the levees. Interior drainage features can consist of reinforced concrete pipe culverts, gatewells, stormwater pumps, and drainage ditches. A preliminary interior flooding analysis was performed for the levee sites in the Preliminary Corps Plan. The results of the analysis are contained in Appendix A, Hydrology and Hydraulics.

Compensatory Storage

The loss of storage at levee and floodwall sites must be evaluated for impacts on downstream stages. Analysis of downstream impacts at the levee locations, detailed in Appendix A, Hydrology and Hydraulics, determined that downstream impacts on stages were very small. Replacement of storage may be mandated by local ordinances; however, there are provisions in the local ordinances to allow for a wavier of the storage mitigation for federal/public projects in cases when the impact is considered insignificant. Waivers will be pursued during subsequent project phases as required. Therefore, if the downstream impact can be considered insignificant, the issue of compensatory storage mitigation regarding this project will require no further evaluations.

Induced Flooding Impacts

Whenever a levee or floodwall is placed in the floodplain, there is the potential for increased river stages both upstream and downstream of the project site. River stages upstream of the site may increase due to a decreased capacity for the channel to convey the flow. This is especially true when the levee or floodwall is constructed in the floodway, the main conveyance channel of the river. Discharges downstream of the site may increase due to a decrease in flood storage available.

Determination of the upstream and downstream impacts on river stages involves a hydraulic modeling effort for each plan formulated. An analysis of impacts downstream of the levees is discussed in Appendix A, Hydrology and Hydraulics. Experience with other similar projects in the area indicates that the increases in flow downstream of the project location due to reduced storage is generally small since the amount of flood storage removed is a very small percentage of the total. Impacts on upstream stages can vary depending on the amount of intrusion into the floodway and the overall localized channel and levee geometry. In some instances, the increase in stage can be reduced to acceptable levels with channel modifications as long as these improvements are incrementally justified.

All levee/floodwall plans developed during this study could result in some level of induced flooding to unprotected areas near the local alternative implemented. Corps of

Engineers' regulation ER-1165-2-26 requires evaluation of all impacts due to construction of a project in the floodplain and to avoid said construction if other practical alternatives exist (consistent with Executive Order 11988). Title 92, Chapter I, subchapter i, part 708 of the Illinois Department of Transportation's proposed rules on floodway construction in northeastern Illinois within the regulatory floodway may require compensatory storage for many of the floodwalls/levees alternatives. In general, State of Illinois criteria limit any increase in the 100-year flood elevations caused by project conditions not to exceed 0.1-foot over the existing condition. Any increases in excess of 0.1 foot can require mitigation, that may consist of the purchase of flowage easements over those properties that will have an additional increase in floodwater depth during the 100-year flood, or replacement of storage lost in the floodway.

According to Corps guidance, when induced flooding results in induced damages, mitigation should be investigated and recommended if appropriate. Mitigation is appropriate when economically justified or when there are overriding reasons of safety, economic or social concerns, or a determination of a real estate taking (flowage easement, etc.) has been made. Mitigation is not necessarily appropriate to comply with state and local laws and regulations. Remaining induced damages are accounted for in the economic analysis.

Lateral Storage Areas

A lateral storage area is defined as a storage area adjacent to the river created by construction of a berm parallel to the river and tied into high ground at both the upstream and downstream ends. An overflow placed at the upstream end of the bermed area and at an elevation below the top of the berm would allow water to spill into the storage area when river stages exceed the overflow elevation. The upstream portion of the berm, at the entry point, is designed to allow controlled inflow to the storage area. Lateral storage areas provide flood storage in two ways. First, by the location of the lateral storage area, flood storage along the riverbank that would have been used early in a storm event is reserved for later in an event. Secondly, additional, flood water storage is provided by locating the overflow at the upstream end of the lateral storage area. The location of the overflow, in conjunction with the normal drop in the water surface from upstream to downstream, provides an additional wedge of storage from upstream to downstream.

Drainage from the lateral storage areas would be accomplished with flap-gated culverts connecting the storage area back to the river. The culverts were sized to dewater the areas within 7 days after the river has receded. Additional culverts can be added to the storage area berm to accelerate de-watering on an as-needed basis.

Provisions will also be included to allow for inflow of low flows in order to minimize the impact on the hydrology of the wetlands. Low flow culverts, will be installed in the berm in order to pass in seasonal flows into the wetland. It should also be noted that

the berm will not impact the normal groundwater regime, and the berm is not impervious, so it will not eliminate all flows from the channel into the lateral storage area.

The design height of the berm was evaluated. Several elevations were modeled but it was decided that elevations over the 100-year level would not be proposed because of the potentially high cost for conforming with the State of Illinois requirements for floodway/floodplain storage mitigation.

Based on soil survey data the surficial soil generally consists of silt and silty clay loam. Since the berms are generally very low, and the areas will be utilized for temporary storage of floodwater, seepage or berm stability problems are considered minimal. Need for routine maintenance and repair for berms and weirs will be addressed in the Operation and Maintenance Manual. Details of available information on surficial geology and soil characteristics, and various components of the proposed lateral storage areas are given in Appendix D, Geotechnical Engineering.

B. Preliminary Corps Plan Components

After the components of the Preliminary Corps Plan were identified, designs were completed, and cost estimates developed, an economic analysis was performed to determine which of the preliminary plan elements was feasible. Only plan elements that have a benefit-cost ratio greater than one, and which maximize net benefits could be considered for inclusion in the federal project. Only plan elements that were supported by the sponsor, and thus implementable were carried further in the plan formulation and analysis. Plan components that were not supported by the local sponsor were dropped from further consideration. The Preliminary Corps Plan consisted of five off-line reservoirs, five lateral storage areas, the Buffalo Creek Reservoir expansion, the Big Bend Lake Reservoir Expansion and five levees. Four off-line detention reservoirs were proposed for Lake County (V, 14a, 17a and 18a), and one was proposed for Cook County (CC1). A description of the elements of the Preliminary Corps Plan is contained in the following sections: Flood Storage Components; Lateral Storage Areas; and Levee and Floodwalls. The location of the preliminary plan sites is shown in Plate 7.

1. Flood Storage Components

Reservoir site V (Plate 8) is just south of the Midlane Golf Course near Gurnee, Illinois on the east side of the Des Plaines River. Once available for flood reduction use, the site should cover an area of about 184 acres with a projected storage capacity of 4,600 acre-ft.

Reservoir 14a (Plate 9) is owned by Lake County and is located near Libertyville on the east side of the Des Plaines River, north of Buckley Road. The tentatively selected plan

is to work with Lake County to increase this reservoir's capacity by another 1,000 acre-feet during flood events. The mined quarry covers an area of about 200 acres, with a current capacity of about 6,000 acre-feet.

Site 17a (Plate 10) is owned by Lake County and is located east of Vernon Hills on the west-side of the river. The reservoir and excavated material storage pile will occupy an area of about 28 acres, and the reservoir will have a flood storage capacity of about 250 acre-feet.

Site 18a (Plate 11) is located north of Half-Day Road in Lincolnshire on the west side of the river, and would be about 26 acres in size with a flood storage capacity of about 305 acre-ft. The landowner is Lake County.

There are two off-stream reservoir sites proposed for Cook County, CC1 and CC3. Site CC1 (Plate 12) is located near Wheeling on the east-side of the river. This 33-acre site has a flood storage capacity of about 335 acre-feet. The work at site CC3 (Plate 13) would be an expansion of Big Bend Lake near Des Plaines. The lake currently covers about 30 acres and is proposed to be lowered by several feet and expanded by another 30 acres, to hold an additional 587 acre-feet of flood storage. The landowner for both CC1 and CC3 is Cook County Forest Preserve District.

Expansion of the existing Buffalo Creek Reservoir (Plates 14 and 15), located on the Buffalo Creek tributary of the Des Plaines River, would result in the addition of 500 acre-feet of additional flood storage. The existing reservoir is located to the west of the river and lies just to the north of Lake-Cook Road. This Lake County reservoir was a joint effort between Lake County and MWRD to reduce downstream flooding in Cook County. The reservoir was completed in 1989 and has a total storage capacity of 700 acre-feet. During construction of this reservoir, material from the excavated areas was used to re-contour the area on either side of Buffalo Creek to provide hills and to screen the reservoir area from local traffic. The plan would eliminate many of these material storage piles, and excavate new areas, in the northern and western portions of the reservoir to create an additional 500 acre-feet of storage. A total of 25 acres will be excavated in these areas, and the resultant excavated material will be stored in a 52-acre area of a former agricultural field to the west of the reservoir site and adjacent to Lake-Cook Road. A sedimentation analysis for this project is detailed in Appendix A, Hydrology and Hydraulics.

2. Lateral Storage Areas

Three lateral storage areas in Lake County (LSA B1, LSA B3a, and LSA B4a) and one in Cook County (LSA B10) were selected for the Preliminary Corps Plan and a fifth site, LSA B6, was selected as part of the wetlands restoration plan. With the exception of LSA B1, wetlands will be restored in these lateral storage areas to further enhance them environmentally and to potentially increase their flood storage capabilities. The majority of

the land at all five lateral storage areas are under public ownership, either by Lake County or Cook County Forest Preserve Districts, with the exception of the southern section of LSA B4a.

LSA B1 (Plate 16) is located at Sterling Lake near Russell on the west side of the Des Plaines River. This area encompasses about 115 acres and will have a flood storage capacity of about 640 acre-ft.

LSA B3a (Plate 17) is located just north of Wadsworth on the west side of the river. It covers about 175 acres and will have a storage capacity of 546 acre-feet. About 100 acres of wetlands will be restored at this site through evacuation and re-contouring. This would result in additional flood storage capacity of at least 300 acre-ft.

LSA B4a (Plate 18) would be located just south of where Mill Creek enters the Des Plaines River, on the west side of the river. This site covers an area of about 110 acres, including a privately owned, semi-active quarry site (about 40 acres) at the south end of the site. Prior to proposed wetland restoration this site will store about 533 acre-feet of floodwaters, which will increase by at least 40 acre-feet after wetlands are restored through excavation and re-contouring.

LSA B6 (Plate 19) is located to the north of Libertyville on the west side of the river. This site encompasses about 140 acres of land and would have a storage capacity of about 650 acre-ft. This site as modeled did not reduce damages downstream but was left as part of the wetland restoration plan.

LSA B10 (Plate 20) is located on the east side of the river at Camp Pine. This 125-acre site would have a storage capacity of 241 acre-ft, with at least 112 additional acre-ft of storage after wetland restoration.

3. Levees/Floodwalls

Five proposed levee sites were included in the alternatives studies in detail, two in Lake County (5 and 27) and three in Cook County (37, 42 and 50). These levees will be constructed along the river to contain between the 50- and 500-year flood event. The heights of the levees will vary from about 1.0 feet to 11.0 feet. The top of the levees (crest) will vary from 5 to 10 feet in width, and the sides will be sloped 2.5 Horizontal to1 Vertical or flatter. The levees will contain a core of impervious material covered with soil. After final contouring, the levees will be seeded with grass. Ownership of land at these levee sites is a combination of public and private parties.

Levee site 5 (Plates 21-24) will be located near Gurnee on the east side of the river. This levee would extend from Route 41 southward to Washington Avenue, a total length of about 8,500 feet. The height and crest width of this levee will vary from 1.1 feet to 8.5 feet (average 6.5 feet) and 5 feet to 10 feet (mostly 10 feet), respectively.

Levee site 27 (Plate 25 and Plate 26) is located to the west of Lincolnshire and the Des Plaines River near Aptakisic Creek. This levee is in two parts and isolates about 90 homes in the Parkwest area from Aptakisic creek. The total length of the levees at this proposed site is about 8,400 feet, with heights varying from 0.3 to 4.6 feet (average 2.5 feet) and crest widths of 5-8 feet (mostly 5 feet).

Levee site 37 (Plates 27-29) is located to the east of Prospect Heights and Mount Prospect and on the west side of the river. This levee extends from north of the junction of Route 45 and Milwaukee Avenue, south along Route 45 to Euclid Avenue. The total length would be about 6,700 feet, with its height varying from 1.5 to 8.5 feet (average 4.2 feet) and crest width 5 to 10 feet (mostly 8 and 10 feet).

Levee site 42 (Plate 30) is in the northeast of the City of Des Plaines and surrounds homes on the west side of the river. The levee surrounds homes in the Hawthorne Lane area across the river from Big Bend Lake. Total length of this levee is about 6,500 feet, with height varying from 2.2 to 11.2 feet (average is 7.5 feet) and crest width 5 to 10 feet (mostly 10 feet).

Levee site 50 (Plates 31-33) is located on the east side of the City of Des Plaines and the river, between Dempster Road on the west and the Tollway on the east. The length of this levee is about 2,600 feet, with its height varying from 2.6 to 7.1 feet (average 3.7 feet) and crest width from 5 to 10 feet (mostly 5 to 8 feet).

Benefit-cost ratios were developed for each of the seventeen plan elements identified during the final plan formulation phase. The results of this first added economic analysis using the HEC-1 MULTIPLAN Optimization model are shown in Table 9.

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Table 9 – Initial Economic Analysis of Preliminary Corps Plan Components

Project Component	Volume (acre-ft)	Average Annual Costs ($K) [1]	Average Annual Benefits ($K) [1,2]	Net Benefits ($K)	Benefit-Cost Ratio
Flood Detention Storage Components					
Reservoir V	4,608	$1,787,885	$1,932,350	$133,000	1.08
Reservoir 14a	1,000	$101,017	$464,894	$335,000	4.60
Reservoir 17a	247	$577,858	$794,012	$199,000	1.37
Reservoir 18a	360	$407,325	$904,805	$458,000	2.22
Buffalo Creek Reservoir	500	$629,996	$1,623,869	$915,000	2.58
Reservoir CC3	587	$767,943	$1,039,493	$250,000	1.35
Reservoir CC1	335	$646,289	$744,047	$90,000	1.15
Lateral Storage Area B1	640	$30,414	$434,480	$372,000	14.29
Lateral Storage Area B3a	546	$87,982	$624,565	$494,000	7.10
Lateral Storage Area B4a	533	$79,293	$544,186	$428,000	6.86
Lateral Storage Area B10	241	$93,413	$257,429	$151,000	2.76
Levee Components					
Levee 5	-	$224,843	$931,960	$651,000	4.14
Levee 27	-	$67,888	$68,431	$500	1.01
Levee 37	-	$262,860	$2,456,984	$2,020,000	9.35
Levee 42	-	$231,361	$1,086,200	$787,000	4.69
Levee 50	-	$521,376	$1,597,800	$991,000	3.06
Total Preliminary Corps Plan					
Total Plan		$6,000,500	$14,275,000	$8,274,500	2.38

[1] Average Annual Costs and Benefits updated from October 95 price levels with an ENR Index of 8.62%. Results updated from initial analysis in October 1996 report.

[2] Average Annual Benefits are based on a first-added analysis

4. Cost Estimates

Construction Cost estimates for each feature of the Preliminary Corps plan were developed based on the available design information and in conjunction with the appropriate guidance. The estimates included allowances for contingencies, planning, engineering and design, construction management, operations and maintenance, relocations, and lands and damages. The unit costs derived for are considered fair and reasonable for a well-equipped contractor and include the contractor's mobilization and demobilization costs, overhead, profit, and bond. The unit prices that were selected for each of the work items were based on historical contractor bid prices for similar work items on other Chicago District construction projects. The most recent bid prices available for a particular work item were examined, and adjustments were made to allow for variation in project

characteristics such as the quantity of work being performed, accessibility of the site, inflation, differences in wage rates or equipment used, and so on. Work item assumptions are indicated in Appendix C, Cost Estimating.

C. LOCALLY PREFERRED PLAN

During the initial review of the October 1996 draft report by Headquarters U.S. Army Corps of Engineers, the report also was provided to the three local sponsors for review and comment. As a result of this review it became apparent that many of the components of the Preliminary Corps Plan would not be acceptable to the local sponsors. The reasons given for non-support included no political and therefore no financial support for the use of forest preserve lands for projects, and encroachment into private properties (See Attachment 1 for a summary of comments received on the preliminary draft report). Recognizing that without public support the plan could not be authorized, the Chicago District provided support to the local sponsors in developing a Locally Preferred Plan (LPP) to provide the Chicago District with an alternate. The plan was intended to be an alternative to the Preliminary Corps Plan elements that would have greater local support.

U.S. Army Corps of Engineers' Headquarters indicated that the locally preferred plan may be recommended without an exception from headquarters under the following conditions: (1) the LPP represents a sponsor constraint; (2) the LPP had greater net benefits than smaller scale plans; (3) the LPP is a smaller scale plan than the NED plan; and, (4) the LPP is composed of incrementally justified elements. The Recommended Plan that resulted from the analysis of the LPP meets all four of these criteria.

The local sponsors with the State of Illinois, Office of Water Resources in the lead, proceeded to conduct meetings with all of the potentially involved communities and agencies. They provided these groups with the preliminary plans for comment and review. Through these meetings and iterations of plans, the local sponsors provided the Chicago District with a list of locally preferred plan elements that were supportable by the locals and by each potential local sponsor in the design and construction phases. The Chicago District then performed detailed design, hydraulic analyses, and benefits analyses on these elements to determine the project elements in which the Corps could participate based on Federal regulations.

1. Elements of the Locally Preferred Plan

The following lists the plan elements as part of the LPP. The location of these sites is shown on Plate 34. Details of the project designs can be found in Appendix B, Civil Design.

North Fork Mill Creek Dam

North Fork Mill Creek Dam (Plate 35) is located in Lake County on North Fork Mill Creek, a tributary of the Des Plaines River. The existing dam was constructed on private property just north of Kelly Road creating Rasmussen Lake. The existing dam is approximately 550 feet in length with a 30-foot crest width at an elevation of 743.2 feet NGVD. The primary spillway is 30 feet in length at an elevation of 738.9 feet NGVD. The proposed plan is to raise the existing dam 3 feet to an elevation of 746.2 feet NGVD. To tie into the existing topography, the new section would be approximately 900 feet in length.

Buffalo Creek Expansion

The local sponsor submitted a locally preferred plan for this site to expand the existing Buffalo Creek Reservoir to Schaefer Road to obtain 476 acre-feet of storage (Plate 36). The plan is a combination of revised contouring in conjunction with lowering the design water elevation of the two existing permanent pools to create one permanent pool. Material excavated from the expansion would be placed offsite at or short haul distance or would be constructively used.

Reservoir CC3 (Big Bend Lake) (LPP)

The local sponsor submitted a plan that combines lowering the existing lake level by 3 feet and expanding the footprint of the lake to increase storage volume (Plate 37). The footprint of the lake would be expanded in the northwest corner and the island removed. This plan provides an additional 108 acre-feet of storage volume. Lowering the existing lake level would require deepening the lake to create a similar depth. All excavated material would be removed from the project site. Pumps would be needed to maintain the existing lake level. The Forest Preserve District has some recreational concerns including maintaining a stable shoreline to accommodate the increased lake level fluctuation while allowing shoreline access, adjusting the boat launch to allow use through the normal range of water fluctuation and the desire to provide a new accessible fishing pier. To address these concerns, riprap would be placed along the new excavated lake edge to prevent erosion, modification of the existing boat launch is proposed, and the construction of a new fishing pier is included in the LPP.

Reservoir Site V

The site is the same as in the Preliminary Corps plan. See Plate 8 for details of the reservoir layout.

Lateral Storage Area - Van Patton Woods (LPP)

The Van Patton Woods Lateral Storage Area is located south of Russell Road and east of the Milwaukee Road R.R. in the Wadsworth area. This site is contained within Lake County Forest Preserve District property. The Van Patton Woods design contains two bermed storage areas, one east and the other west of the river. A plan view and typical sections are shown in Plates 38 and 39. This site is approximately 66 acres and 412 acre-feet of flood storage.

Levee 5 - Gurnee

This site is the same as in the Preliminary Corps Plan. See plates 21-24 for alignment and location of specific features.

Levee 27 - Aptakisic Creek

This site is the same as in the Preliminary Corps Plan. See plates 25 and 26 for alignment and location of the specific features.

Levee 37 - Prospect Heights/Mount Prospect (LPP)

This feature proposed by the local interests consists of raising roads to hold back floodwater effectively operating as a levee. Milwaukee Avenue would be raised from just south of Palatine Road to the intersection of Des Plaines River Road. Des Plaines River Road would be raised from Milwaukee Avenue to just north of Euclid Avenue. The alignment and location of specific features are shown on Plate 40. See Plate 41 for typical road raise sections of Milwaukee Avenue and Des Plaines River Road. The road raise is approximately 6,800 feet long. The crest elevation is 640.9 feet NGVD at an index location.

Levee 42 - Big Bend Lane/ Hawthorne Lane (LPP)

This feature is a floodwall that extends from Hawthorne Lane along Rand Road to the river, then follows the river around the Big Bend subdivision to tie into the Chicago & Northwestern. RR embankment. The floodwall is 6,430 feet long with crest elevation of 634.5 feet NGVD. See Plates 42 and 43 for the layout and location of specific project features.

Levee 50 Rand Park

This site is the same as in Preliminary Corps plan. See Plates 31, 32 and 33 for the layout and location of specific project features.

2. Cost Estimates

The construction cost estimates for the LPP features are based on October 1998 price levels. The estimates include allowances for contingencies, planning, engineering and design, construction management, operations and maintenance, and lands and damages. The unit costs derived for these project features are considered fair and reasonable for a well-equipped contractor and include the contractor's mobilization and demobilization costs, overhead, profit, and bond. The unit prices that were selected for each of the work items were based on historic contractor bid prices for similar work items on other Chicago District construction projects. The most recent bid prices available for a particular work item were examined, and adjustments were made to allow for variation in project characteristics such as the quantity of work being performed, accessibility of the site, inflation, and differences in wage rates or equipment used. Work item assumptions are discussed in Appendix C, and also are noted on the estimate sheets for each feature. Historic bid abstract data was not available for certain project elements, and in those situations, Means Construction cost data was used.

Uncertainty exists in all cost estimates, and since detailed plans and specifications have not yet been prepared, a contingency factor has been applied to each of the estimates to allow for unanticipated details or revisions to the preliminary design or to the cost estimating assumptions used. Proper use of contingency management is consistent with current guidance on the preparation of feasibility report estimates (ER 1110-2-1150). Selection of contingency factors considered the level of design, the level of detail of site condition data, the source of impervious fill materials, bidding climate in the area, and the level of the lump sum or unit prices used. An outline of the primary items of concern that dictated the selection of the contingency factor for each project can be found in Appendix C, Cost Estimating. The contingencies applied range from 15 percent to 45 percent of construction costs.

The costs for planning, engineering, and design include all engineering and design activities that are required before, during, and after construction. At this stage of design, these costs conservatively are assumed to be 20 to 25 percent of the total construction costs including relocations, for all projects. The costs for construction management cover all personnel, services, and equipment necessary for the completion of each of the projects. At this stage of design, these costs are

assumed to be 7.5 percent of the total cost for construction, including relocations for all projects. The 7.5 percent rate is the current construction management rate for all flood control construction projects in the Lakes and Rivers Division of the Corps of Engineers.

3. Benefit-Cost Assessment

The costs and benefits of each element included in the LPP were first evaluated by comparing the flood water storage residual project damages to the baseline condition damages. Those elements that were economically justified on a first-added basis were then analyzed on a last-added basis. Table 10 and Table 11 list the average annual benefits, average annual costs, and benefit-cost ratios for the LPP project elements on a first and last-added basis, respectively. The benefits were evaluated with traditional economic models using results from the HEC-1 and HEC-2 analyses (see Appendix A, Hydrology and Hydraulics). A future growth adjustment factor of 17.51 percent accounts for the projected growth in with-project benefits consists of damage and benefits established for the year 2004 (a composite project on-line year when half the projects will be on line). The adjustment for future benefits is based on projected changes in the hydrology of the watershed due to future development. See Section 9, Part 5, Appendix E, Economics for background on the development of this factor. Due to this adjustment, these values differ from the model output results presented in Appendix A, Hydrology and Hydraulics.

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Table 10 - First Added Analysis of the Locally Preferred Plan Project Elements

Project Component	Volume (acre-ft)	Average Annual Cost[1] ($000)	Average Annual Benefits ($000)	Net Benefits ($000)	Benefit Cost Ratio
Van Patton Woods	412	$348	$558	$264	1.90
Reservoir Site V [2]	4,608	$1,753	$690	($924)	**0.43**
North Fork Mill Creek Dam	916	$301	$424	$158	1.59
Buffalo Creek	476	$447	$972	$513	2.12
Big Bend Lake [3]	108	$292	$130	($142)	**0.48**
Levee 5 [2]		$794	$20	($774)	**0.03**
Levee 27 [2]		$84	$61	($23)	**0.73**
Levee 37		$831	$2,040	$1,255	2.61
Levee 42 [4]		$631	$795	$165	1.26
Levee 50		$622	$1,785	$1,212	3.13

[1] All costs at 10-98 price levels. All benefits escalated to October 1998 price levels.

[2] LPP Elements dropped from further consideration.

[3] Big Bend Lake LPP dropped from further consideration; however, the Preliminary Corps Plan (PCP) component at Big Bend was endorsed by local interests and so replaced the LPP version of Big Bend with the larger PCP version

[4] Local Support was withdrawn for this element, so the feature was dropped.

As noted in the breakdown of the first added analysis (Table 10), four of the LPP elements did not pass the test of economic feasibility [Site V, CC3 (Big Bend Lake-LPP), Levee 5, and Levee 27] and one site no longer had a local sponsor (Levee 42). Therefore, last added analyses were performed on the remaining five elements, all of which were incrementally justified. Also, at the urging of the local sponsor and other local officials, Big Bend Lake, at the larger, Preliminary Corps Plan size, was reintroduced into the Locally Preferred Plan. As was done for the other features, a first and last added analysis was performed for the larger Big Bend Lake. The results of both analyses are contained in Appendix E, Economics. The results of the last added analysis are contained in Table 11.

As was outlined in the previous section, the only Federally supportable plan elements would be those that have local support and that are incrementally justified. The first and last added analyses showed that the following six project elements were incrementally justified: North Fork Mill Creek Dam, Van Patton Woods Lateral Storage Area, Buffalo Creek Reservoir Expansion, Levee 37, and Levee 50 and Big Bend Lake.

Table 11 - Last Added Analysis of the Locally Preferred Plan Project Elements ($1000)

Locally Preferred Plan Project Component	Volume (acre-ft)	Annual Project Total Cost	Annual Project Benefits	Net Benefits	Benefit to Cost Ratio
Van Patton Woods	412	$348	$493	$145	1.44
North Fork Mill Creek	916	$301	$432	$131	1.42
Buffalo Creek	476	$447	$638	$191	1.43
Big Bend Lake (PCP) [1]	587	$849	$914	$65	1.08
Levee 37		$831	$1,732	$901	2.08
Levee 50		$622	$1,570	$948	2.52

[1] Local support was provided for the PCP configuration of Big Bend Lake Expansion, after the LPP size failed to be justified. The larger PCP size is shown here.

D. OPTIMIZATION ANALYSIS OF THE LOCALLY PREFERRED PLAN

In order to satisfy the conditions for approval of a locally preferred plan instead of a federal, NED Plan, an additional optimization analysis of the flood storage components of the locally preferred plan was performed. Per Corps guidance, the LPP must have greater net benefits than a smaller scale plan. It must have a smaller scale than an NED Plan. The LPP components must reflect the NED size or a sponsor constraint must be identified and each element of the plan must be incrementally justified. The final optimization analysis was completed after it was determined that each of the remaining Locally Preferred Plan components was incrementally justified.

1. Optimization of the Detention Storage Components

The MULTIPLAN Optimization routine was used to optimize the reservoirs and to satisfy the constraints for recommendation of the Locally Preferred Plan. The results of the optimization analysis are contained in Table 12, and discussed for each individual element in the following paragraphs.

The analysis was performed using the HEC-1 MULTIPLAN Optimization model, which was utilized for the optimization of the Preliminary Corps Plan. The design elements and cost curves for each of the storage features were re-evaluated and revised the optimization analysis provided economic results for a smaller size plan and a larger size plan than the Locally Preferred Plan component size.

Van Patton Woods LSA – Volumes in the range of 349 to 525 acre-feet were tested in the optimization model. The costs for volumes smaller than the LPP size were developed based

on know features of the site. Larger volumes would require additional excavation and removal of floodplain material for additional storage, with appropriately higher costs. The results of the analysis indicated that the LPP size of 412 acre-feet was the optimum size for the site based on cost constraints.

North Fork Mill Creek Dam – Total volumes in the range of 600 to 1,007 acre-feet were simulated for the North Fork Mill Creek Dam. The costs for the smaller volumes were estimated based on known costs for specific dam modifications: dewatering, slurry wall, outlet work, earthwork, etc. For a larger volume of storage at this site, several additional costs were identified: a road relocation; utility relocations; and an urban ring levee. These additional features would be required to offset damages to the neighboring community and a nearby road associated with a larger dam pool. The costs for the road raise and utilities were developed from the Mill Creek dam analysis. The ring levee costs were based on current levee costs on District construction contracts. The results of the optimization analysis indicated that the LPP size was the optimum size for the site based on cost constraints.

Buffalo Creek – Total expansion volumes in the range of 200 to 800 acre-feet were simulated in the MULTIPLAN model for Buffalo Creek. Cost for smaller volumes were estimated based on fixed costs for the modification to any know structures, such as the low flow culverts, the outlet works, erosion protection, and embankment. The optimum size for the Buffalo Creek Expansion appears to be an expansion of 800 acre-feet of storage. However, the size of the Buffalo Creek Expansion in the LPP is based on a sponsor constraint. Therefore, a larger size reservoir was not recommended. The optimization results showed that net benefits were increasing through the recommended size.

Big Bend – Expansion volumes on the order of 494 to 640 acre-feet were tested in the Optimization model for Big Bend Lake. Costs for volumes lower than the recommended volumes were based on fixed costs associated with any modification at the site. As at North Fork Mill Creek, a larger size reservoir at Big Bend would necessitate a relocation of an adjacent roadway and associated utilities. The cost estimate used for the road relocation at North Fork Mill Creek was used for the Big Bend Lake analysis. The results of the optimization analysis indicate that the recommended size of 587 acre-feet was the optimum for the site.

Table 12 – Optimization Results for Locally Preferred Plan Components

Reservoir Size (acre-feet)	Average Annual Costs ($000)	Average Annual Benefits ($000)	Average Annual Net Benefits ($000)	Benefit Cost Ratio.
Van Patton Woods Lateral Storage Area				
349	$197	$452	$255	2.29
412	$221	$511	$290	2.31 [1]
525	$334	$614	$280	1.84
North Fork Mill Creek Dam [2]				
600 (100)	$196	$438	$242	2.23
916 (500)	$216	$545	$329	2.52 [1]
1,007 (591)	$362	$583	$221	1.61
Buffalo Creek [2,3]				
900 (200)	$324	$157	-$167	0.48
1,250 (550)	$420 .	$1,132	$712	2.70
1,500 (800)	$486	$1,683	$1,197	3.46
Big Bend				
494	$500	$536	$36	1.07
587	$735	$1,029	$294	1.40 [1]
640	$790	$1,067	$277	1.35

[1] Maximum Net Benefit size at site.
[2] Total Volume Optimized. Expansion volumes amounts are shown in parentheses.
[3] Recommended size is smaller than optimized volumes, but (476 acre-feet expansion) is based on a sponsor constraint.

2. Optimization of the Levee Components

The optimization analysis performed by HEC for the Chicago District, and discussed in regards to the Preliminary Corps plan was adopted for the Locally Preferred Plan levee components, Levee 37 and Levee 50. The HEC levee optimization analysis developed for the five PCP levee components was re-evaluated for the two remaining LPP levees. The previously developed damage reduction data was utilized with updated cost data to develop a benefit cost relationship for each of the levee units. Where applicable, topographic site constraints such as tiebacks, road relocations, etc. were incorporated into the cost curves when those items could have a significant impact on the feature cost. For example, at the Rand Park levee, a higher floodwall would require a road raise for a major thoroughfare. At the Mount Prospect road raise, a higher level of protection would require modification of a four-lane overpass. Road raise costs utilized were developed from previous road raise analyses performed for the feasibility study. Utilizing all available information, and engineering judgement, the optimization analysis was completed. The height of each unit

was optimized to a break point in the benefit-cost relationship. The results of the current analysis are contained in Table 13.

Table 13 – Optimization of Locally Preferred Plan Levee Components

Levee Crest Elevation [1] (ft. NGVD)	Damages Reduced ($000) [2]	Project Costs ($000)[3]	Net Benefits ($)
Levee 37 - Mount Prospect & Prospect Heights.			
640	$1,852	$648	$1,204
640.9	**$2,000**	**$781**	**$1,455** [4]
641.5	$2,100	$927	$1,173
Levee 50 – Rand Park			
653.0	$1,102	$546	$556
653.3	**$1,120**	**$561**	**$746** [4]
653.8	$1,280	$739	$541

[1] Levee Crest elevations vary along the levee profile. The levee crest elevation is shown at a selected index point used in the analysis.
[2] Damage figures based on risk analysis performed by HEC. Damages extrapolated for elevations that exceeded original analysis.
[3] Average annual costs are total annual investment costs.
[4] Adopted, optimized levee crest elevation.

E. RISK AND SENSITIVITY ANALYSES

The risk analysis for this project is based on the EM 1110-2-1619 dated August 1996 "Risk Based Analysis for Flood Damage Reduction Studies." Risk based analyses are being phased into Corps planning and design studies. Methods of analysis will be refined as experience is gained. All benefits claimed for this project reflect the required analysis. A discussion of the development of the uncertainties surrounding the hydrology and hydraulic parameters and detailed results from the risk and uncertainty modeling can be found in Appendix A, Hydrology and Hydraulics. Additional details are contained in Attachment 2, Risk and Sensitivity Analyses. A discussion of the development of the uncertainties surrounding the economic damage parameters can be found in Section 8, Appendix E, Economics.

Attachment 2, Risk and Sensitivity Analysis, outlines the analysis used with the preliminary Corps Plan determination. Adjustment factors were utilized for subsequent analyses (LPP, Recommended Plan) consistent with the results of the risk and uncertainty analysis. The application in risk and uncertainty resulted in an increase of 15 percent in the total, baseline condition compared to results developed

prior to the application of risk and uncertainty analyses (Appendix A, Attachment 5). This factor was reviewed during the progression from general to specific project features. Consequently, due to the uneven geographic distribution of impacts on damage estimates from the application of risk and uncertainty, a more conservative increase of 5 percent was applied during the first-added and last-added analyses of the LPP. The 5 percent adjustment factor was also carried over to the entire with and without project conditions damage estimates.

A future condition sensitivity analysis is also presented in Appendix A, Attachment 5. The results of the sensitivity analysis demonstrate the robustness of the proposed plan in that regardless of the future condition assumption, significant stage reductions compared to without project conditions will be achieved. The results presented also emphasize the critical need for the incorporation of both a flood control plan (including storage components) and strict development ordinances to control future development in the watershed, particularly within the floodplain. Both of these measures are necessary to prevent flooding and the resultant damages from escalating above present conditions. The Preliminary Corps Plan provided significantly more storage than the Locally Preferred Plan. Without this storage the impacts of future development will be more profound.

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VI. RECOMMENDED PLAN

Based upon the primary project purpose and local coordination and support, five elements of the Locally Preferred Plan and one element of the Preliminary Corps Plan form the Recommended Plan. The elements of the Recommended Plan have been optimized and incrementally justified. The Recommended Plan components are smaller than or equal to the size that maximizes net benefits. The Recommended Plan components have greater net benefits than smaller versions of the same components. The plan is locally supported and implementable. It is therefore considered to be the Federally supportable plan for flood damage reduction.

A. PLAN DESCRIPTION

Table 14 outlines the recommended plan for the Des Plaines River Feasibility Study, based on the alternative analysis and coordination with the local sponsor and communities. The selected plan is composed of a number of different plan elements including two reservoir expansions, one dam modification, one lateral storage area, and two levees as described in the following paragraphs. The location of these sites is shown on Plate 44. The Recommended Plan also includes the implementation of a flood warning plan throughout the basin, and re-mapping of the mainstem floodplain at the conclusion of project construction. Details of the flood warning plan are provided in Appendix I. The evolution of the Recommended Plan from the Preliminary Corps Plan and the Locally Preferred Plan is contained in Table 15.

Table 14 - Recommended Plan for Reducing Flood Damages

Project	Location	Primary Owner(s)	Expanded Storage Volume (acre-feet)
North Fork Mill Creek	Lake County Old Mill Creek	Private	500
Van Patton Woods Lateral Storage Area	Wadsworth Russell	Lake County Forest Preserve District	412
Buffalo Creek Expansion	Buffalo Grove	Lake County Forest Preserve District	476
Big Bend Lake Expansion	Des Plaines	Cook County	587
Levee 37 – Prospect Heights &Mount Prospect	Prospect Heights Mount Prospect	Illinois Dept of Transportation , Cook County Forest Preserve District	-
Levee 50 – Rand Park	Des Plaines	Private (commercial)	-
Total Storage			1,975

Table 15 - Evolution of Elements in Recommended Plan

Project Element	Preliminary Corps Plan Plate 7	Locally Preferred Plan - May 1997 - Nov. 1997 Plate 33	Recommended Plan June 1999 Plate 44	Reason for Elimination
Reservoir Site V	X	X		First Added BCR in LPP < 1
Reservoir 14a	X			Local sponsor will not support
Reservoir 17a	X			Local sponsor will not support
Reservoir 18a	X			Local sponsor will not support
Buffalo Creek Reservoir Expansion	X	X (modification)	X (modified)	
Reservoir CC3 (Big Bend Lake)	X	X (modification)	X	Preliminary Corps Plan supported by local interests. First Added BCR in LPP < 1
Reservoir CC1	X			Local sponsor will not support
Lateral Storage Area B1-Sterling Lake	X			Local sponsor will not support
Lateral Storage Area B3a-Wadsworth	X			Local sponsor will not support
Lateral Storage Area B4a – Townline Rd. South	X			Local sponsor will not support
Lateral Storage Area B6 - Riverhill Forest Preserve	X			Local sponsor will not support
Lateral Storage Area B10-Camp Pine	X			Local sponsor will not support
Levee 5 – Gurnee	X	X		First Added BCR in LPP < 1
Levee 27 – Aptakisic Creek	X	X		First Added BCR in LPP < 1
Levee 37 – Prospect Heights/ Mount Prospect	X	X (modification)	X (modification)	
Levee 42 – Big Bend Lane/Hawthorne Lane	X	X (modification)		No local sponsor support.
Levee 50 – Rand Park	X	X	X	
North Fork Mill Creek		X	X	
Van Patton Woods LSA		X	X	

1. Van Patton Woods Lateral Storage Area

The Van Patton Woods Lateral Storage Area is located south of Russell Road and east of the Milwaukee Road R.R. in the Wadsworth area. This site is contained within Lake County Forest Preserve District property. The Van Patton Woods design contains two bermed storage areas, one east and the other west of the river. A plan view and typical sections are shown in Plates 38 and 39. This site provides approximately 66 acres and 412 acre-feet of flood storage.

2. North Fork Mill Creek Dam

The North Fork Mill Creek Dam is located in Lake County on the North Fork of Mill Creek, a tributary of the Des Plaines River. The existing dam was constructed on private property just north of Kelly Road creating Rasmussen Lake. The existing dam is approximately 550 feet in length with a 30-foot crest width at an elevation of 743.2 feet NGVD. The primary spillway is 30 feet in length at an elevation of 738.9 feet NGVD (Plate 34). The proposed plan is to raise the existing dam 3 feet to an elevation of 746.2 feet NGVD to obtain an additional 500 acre-feet of storage. To tie into the existing topography the new section would be approximately 900 feet in length. The maximum storage volume increased to 1,040 acre-feet.

3. Buffalo Creek Expansion

The plan for this site is to expand the existing Buffalo Creek Reservoir to Schaefer Road to obtain 476 acre-feet of floodwater storage (Plate 35). The plan is a combination of revised contouring in conjunction with lowering the design water elevation of the two existing permanent pools to create one permanent pool. Material excavated from the expansion would be placed offsite.

4. Big Bend Lake Expansion

The plan for this site is to expand the existing Big Bend Lake to obtain an additional 587 acre-feet of storage (Plate 13). The plan uses the Preliminary Corps Plan configuration for the expansion and re-contouring of the lake bottom and slopes. The plan also calls for a lower normal lake level for floodwater storage. Material excavated from the expansion would be disposed on site. Two storm sewer lines, which empty into Big Bend Lake, a 96-inch and a 24-inch, would be rerouted to the Des Plaines River to eliminate the reduction in storage in Big Bend Lake that would have occurred if those storm sewers were not rerouted.

5. **Levee 37 - Prospect Heights/Mount Prospect LPP**

This feature proposed by the local interests consists of raising roads to hold back floodwater, effectively operating as a levee. Milwaukee Avenue would be raised from just south of Palatine Road to the intersection of Des Plaines River Road. Des Plaines River Road would be raised from Milwaukee Avenue to just north of Euclid Avenue. The alignment and location of specific features are shown on Plate 40. Typical road raise sections of Milwaukee Avenue and Des Plaines River Road are shown on Plate 41. The road raise including tiebacks is approximately 8,500 feet long. The crest elevation is 640.9 feet NGVD at the roadway shoulder. The height of the road raise ranges between 0.5 feet and 5.0 feet. The plan also includes gravity drainage facilities and a small, 20,000 gpm, pumping plant.

A preliminary interior flooding analysis was performed for all of the leveed areas, including Levee 37. The results of the interior hydrology analysis are contained in Addendum 1 to Appendix A, Hydrology and Hydraulics. Additionally, a preliminary economic analysis of the interior facilities was performed based on a comparison of a baseline condition (minimum facility) drainage facility versus an interior drainage design that included a small pumping facility. The preliminary analysis, detailed in Table 16, below, indicates that there are sufficient benefits to support an interior drainage pumping facility in addition to modifications to the existing gravity drains. The drainage design also includes two additional gravity drains, (60-inch reinforced concrete culverts) which were added to enhance the gravity capability. Additional information on the economic analysis associated with the interior drainage facilities is contained in Appendix E, Economics, Section 10.a. The drainage design for Levee 37 will be re-evaluated during the design phase, to determine if enhanced drainage facilities should be considered.

Table 16 - Interior Flood Control Facility Analysis for Levee 37

Project Element	Average Annual Benefits ($000)	Average Annual Costs ($000)	Benefit to Cost Ratio [1]
Levee 37 w/ basic drainage [2]	$1,382.3	$501.3	2.8
optimized drainage features	$210.8	$144.9	1.5
Levee 37 w/ additional drainage [3]	$1,593.1	$646.2	2.4

[1] Includes induced damages.
[2] Associated residual overbank flood damages of $65,200 and residual interior flood damages of $284,700.
[3] Associated residual overbank flood damages of $65,200 and residual interior flood damages of $73,900.

6. Levee 50 - Rand Park

Levee site 50 is located in the City of Des Plaines and on the east side of the Des Plaines River, between Dempster Road on the west and the Tollway on the east. The length of this levee is about 2,600 feet, with its height varying from 3.8 to 9.0 (average 5.3 feet) and crest width from 8 to 10 feet (mostly 8 feet). See Plates 30, 31 and 32 the layout and location of specific project features. The LPP plan for Levee 50 included interior drainage features. A review and analysis of the proposed interior pumping features for the Rand Park levee was performed to determine benefits, damages, average annual costs, average annual benefits associated with the three different pumping scenarios, and one for one scenario without pumping. The analysis indicates that there are sufficient benefits to support the installation of a pump station and additional gravity drainage features. A summary of the analysis is contained in Table 17. Additional information regarding the hydrologic and economic analyses are contained in Appendices A and E, respectively.

Table 17 - Interior Flood Control Facility Analysis for Levee 50

Project Element	Average Annual Benefits ($000)	Average Annual Costs ($000)	Benefit to Cost Ratio [1]
Levee 50 w/ basic drainage [2]	$1,112.5	$504.1	2.2
additional drainage features	$284.9	$117.9 [4]	2.4
Levee 50 w/ additional drainage [3]	$1,397.4	$622.0	2.3

[1] Includes induced damages.
[2] Associated residual overbank flood damages of $139,700 and residual interior flood damages of $284,900.
[3] Associated residual overbank flood damages of $139,700 and residual interior flood damages of $32,900.
[4] Pumping costs for 250 cfs pumping obtained from H & H analysis. Costs without pumping determined from total cost minus pumping costs.

B. IMPACTS OF PLAN ELEMENTS EVALUATED

1. Hydrologic/Hydraulic Impacts

A comparison of water surface profiles with and without project conditions at the three, mainstem gages was developed during the Hydrologic and Hydraulic analyses. A summary of differences between the with and without project year 2010 future condition water surface profiles was developed for the Recommended Plan. Relative differences between water surface profiles for future with and without project conditions are similar to those differences for the baseline condition. The storage components of the Recommended Plan have an influence both under baseline conditions and under a future urbanized watershed condition. The Recommended Plan supported by the local sponsors has significantly less storage than the Preliminary Corps Plan. Based on the results of the comparison of baseline with and without Recommended Plan conditions, a maximum stage

reduction of 0.12 feet for the 100-year (1% chance exceedance event) is noted. Data summarized from Appendix A, Hydrology and Hydraulics, is contained in Table 18.

Table 18 - Comparison of Baseline Water Surface Elevations With and Without the Recommended Plan

River Stage Comparison	Water Surface Elevation (feet) Differences for With versus Without Project Conditions		
	Gurnee Gage to Russell Road Gage	Des Plaines Gage to Gurnee Gage	Riverside Gage to Des Plaines Gage
10-year Event			
Maximum Decrease	-0.18	-0.17	-0.16
Maximum Increase	-	-	-
100-year Event			
Maximum Decrease	-0.12	-0.10	-0.10
Maximum Increase	-	+0.11	+0.03

The loss of storage at the levee sites was evaluated for impacts on stages downstream of the levees and the impact was considered insignificant at the Rand Park Levee for the 100-year storm. We have noted a stage increase of around 0.11 feet for the 100-year event near the Mount Prospect Levee. It is anticipated that detailed modeling of the levee site during the detailed design stage along with minimal floodplain clearing riverward and adjacent to the levee will result in stage impacts on the 100-year event less than the regulatory limit (0.05 feet). Therefore, it is expected that a waiver will be issued based on state laws and/or local ordinances that allows for the waiver of storage mitigation requirements for federal/public projects in such cases where the impacts are insignificant.

2. Recommended Plan Impacts

Project Costs

The estimated construction costs and annual costs of the project features, which were evaluated, are summarized in Table 19. Construction costs are based on October 1998 price levels and include varying contingencies (see Appendix C, Cost Estimating). Pre-construction engineering and design (PED) is estimated at 20 to 25 percent of the construction cost and Construction Management (CM) is estimated at 7.5 percent of the construction cost. The average annual costs are based on an interest rate of 6-7/8 percent and a project life of 50 years.

Estimated land costs shown in Table 23 are based on gross appraisals developed by the Corps of Engineers. Interest during construction was based on a construction period of either one year (Levee 37, Levee 50, Van Patton Woods, North Fork Mill

Creek Dam) or two years (Buffalo Creek Reservoir and Big Bend Lake) for each project element. The economic value of lands and damages was included in the computation of the average annual costs and net benefit, which was then used in the computation of the benefit-cost ratio.

Project Benefits

Project benefits include the reduction in flood damages and related costs and the reduction in certain flood insurance policy costs for basin residents. Flood damage reduction benefits have been divided into several categories, which include single-family residential, multi-family residential, commercial/industrial, and three categories of transportation damages and are shown in Table 20

National Flood Insurance Cost Savings

According to guidance on levee certifications developed in early 1997 by the U.S. Army Corps of Engineers, both the proposed Rand Park Levee (Levee 50) and the proposed Mount Prospect/Prospect Heights Levee (Levee 37) meet the requirements for FEMA certification (100 year level of protection) by the Corps of Engineers. The reduction in flood damages achieved by the projects allows home-owners to delete insurance coverage. The cost-savings is the reduction in administrative and overhead/project expenses incurred with such insurance policies. Current regulations allow claiming a benefit only for policies now in effect. Approximately 1,583 policies are now in effect in the watershed. The annual savings per policy for administration and overhead costs of the insurer averages $138. Average annual cost savings were calculated to be $5,382 for the Rand Park Levee (Levee 50) and $12,558 for Levee 37. A more detailed evaluation of the reduction in Flood Insurance Administration Costs is presented in Section 9, Part 2, Appendix E, Economics.

Table 19 - Estimated Construction Costs, Annual Costs and Benefit Cost Ratios for the Recommended Plan

Recommended Plan	North Fork Mill Creek Dam	Van Patton Woods Lateral Storage Area	Buffalo Creek Reservoir Expansion	Prospect Heights/ Mount Prospect Levee[6,7]	Rand Park Levee	Big Bend Lake Expansion[8]	Project Totals
Construction Cost [1]	$2,246,900	$2,997,400	$4,481,390	$7,645,700	$5,246,600	$6,779,000	$29,396,990
Relocations	$0	$0	$0	$579,800	$14,200	$1,167,600	$1,761,600
Engineering and Design (20-25%)[2]	$561,725	$599,480	$896,278	$1,645,100	$1,052,160	$1,589,320	$6,344,063
Construction Management (7.5%)[3]	$168,518	$224,805	$336,104	$616,913	$394,560	$595,995	$2,336,894
Lands and Damages[4]	$791,589	$25,341	$60,378	$905	$805,241	$113,084	$1,796,537
Total First Costs	$3,768,731	$3,847,026	$5,774,150	$10,488,417	$7,512,761	$10,244,999	$41,636,085
Interest During Construction [5]	$164,831	$169,963	$483,252	$464,081	$371,996	$857,343	$2,511,466
Total Investment Cost	$3,933,562	$4,016,989	$6,257,402	$10,952,498	$7,884,757	$11,102,342	$44,147,551
Total Annual Investment Cost	$280,542	$286,492	$446,278	$781,132	$562,341	$791,819	$3,148,603
O & M Costs	$21,911	$61,109	$18,349	$52,569	$59,799	$57,472	$273,209
Total Costs Annualized	$302,453	$347,601	$464,627	$833,701	$622,140.	$849,291	$3,421,812
Annualized Benefits with Full Damage Growth Index	$431,598	$493,468	$637,796	$1,732,327	$1,570,116	$913,992	$5,779,297
First Added Net Benefits	$129,145	$145,867	$173,169	$898,626	$947,976	$64,701	$2,357,485
B/C Ratio	1.43	1.42	1.37	2.08	2.52	1.08	1.69

1 Construction Costs include Mitigation Costs.
2 Engineering and Design (E & D) rates set at 20% for all features except North Fork Mill Creek Dam. E & D rate for Mill Creek Dam is 25%.
3 Construction Management (S & A) rates set a 7.5% for all LRD flood control construction per CELRC-ET-CO-C memorandum dated 13 Nov 1998.
4 Only economic costs for lands and damages included. See Appendix E, Section 9, Part II.
5 IDC Computation are based on the total Design and Construction Period. Complete IDC computations contained in Appendix E.
6 Levee 37 Project cost includes $40,000 FWPP costs
7 The O & M costs includes $3,000 per year for the FWPP System. (Appendix I)
8 Big Bend Construction cost includes $30,000 for FIRM re-mapping at the end of project construction. Cost added to last construction element.

Table 20 - Average Annual Damage Summary for With and Without Project Conditions

Damage Category	Year 2004		
	Without Project Baseline Damages [1]	With Project Baseline Damages [1]	Baseline Damage Reduction
Single-Family Residential	$2,993,300	$2,130,900	$862,400
Multi-Family Residential	$1,986,700	$705,000	$1,281,700
Commercial/industrial/ public	$1,958,800	$1,129,300	$829,500
Road Repair	$2,276,100	$1,914,400	$361,700
Road Flood Delays	$5,817,900	$4,963,200	$908,700
Road Repair Delays	$9,221,200	$7,699,300	$1,521,900
Emergency Costs	$920,500	$703,000	$217,500
Total	$25,228,500	$19,245,100	$6,001,300 [2]

[1] (Applicable Discount rate 6-7/8% at October 1998 Price Levels); Source: Sections 10.a, Appendix E, Economics.
[2] Damage reduction includes $17,900 in FIA Administrative Cost Reductions.

3. Floodplain Impacts

The construction of all of the project features will result in modifications to the 100 year floodplain on the mainstem Des Plaines River. Floodplain mapping will need to be modified once project elements are constructed. It is anticipated that map amendments will be made to the leveed areas based on Corps of Engineers data and requests from the communities. In addition, mainstem impacts attributable to the storage elements will also necessitate changes in the 100-year floodplain. Mainstem remapping will be completed once the last storage element is completed. Costs to complete the remapping are included in the construction cost of the final construction element (Big Bend Lake.)

4. Environmental Quality Impacts

The U.S. Fish and Wildlife Service, the U.S. Environmental Protection Agency, the Northeastern Illinois Planning Commission, and the Lake and Cook County Forest Preserve Districts have actively participated in the environmental review and assessment of the selected plan. Coordination through direct office contact and on-site field reviews and surveys was maintained throughout the study. The environmental quality impacts are summarized in Section XI of this report and in the attached Environmental Impact Statement (EIS).

C. MITIGATION

The principle adverse impact would be a loss of about 24 acres of wetland as a result of construction and operation of the flood control project. Implementation of the wetland mitigation at Van Patton Woods LSA and Buffalo Creek Reservoir would result in the restoration of 65 acres of scrub-shrub and forested wetlands. Additional

information on the wetland mitigation is contained in the Environmental Impact Statement.

D. CONSTRUCTION SCHEDULE

The construction schedule based on the completion of the Chief of Engineer's report in 1999 and project authorization by the Congress is shown on Table 21. It is assumed that the levee components and lateral storage areas will then be constructed at an early stage to provide near-term protection to the high average annual damage locations.

Table 21 - Proposed Design and Construction Schedule

Project Feature	Engineering and Design Start	Construction Start	Construction Completion
Levee 50[1]	1999	2000	2001
Levee 37	1999	2001	2002
Van Patton Woods	2000	2002	2003
North Fork Mill Creek	2001	2003	2004
Buffalo Creek Reservoir Expansion	2002	2004	2006
Big Bend Lake Expansion	2003	2005	2007

[1] The State of Illinois is seeking to construct this element and receive reimbursement under Section 104 of the 1968 Rivers and Harbor Act.

E. DESIGN AND CONSTRUCTION CONSIDERATIONS

In general, design and construction considerations are similar and applicable to all features of the project: reservoirs, lateral storage areas, and levees. The considerations include, but are not limited to the following items:

- All sites need to be accessible for the required construction equipment via public roads or access roads built for construction.

- A traffic control plan needs to be developed to temporarily re-route or detour traffic, if necessary, during construction.

- Project features have been sited to minimize damage to forest preserves, wetlands, homes, roads, businesses, and other existing structures. Damages to wetlands and forest preserves resulting from construction will require mitigation.

- Since some of the features are near the river there will be construction in the 100-year floodplain. Losses in flood storage due to construction in the floodplain were accounted for in the storage capacity of each feature.

- A plan to deal with flooding during construction will need to be developed to minimize damage to the project features. Due to the geology of the project area, in general consisting mainly of sands and gravels, dewatering during construction will be required for reservoir excavation.

- Suitable borrow material for the construction of reservoir liners and berms will be obtained from North Branch Chicago River Reservoir Numbers 15 and 27 excavated disposal areas. Designated haul routes will be identified.

- Any utilities that cannot be avoided will need to be relocated. The main utility concerns will be in connection with construction of the levees because they are constructed in residential and commercial areas near homes, streets, and businesses.

- NPDES permits must be obtained prior to the onset of construction The contractor must ensure that both his firm, as well as any subcontractors is in compliance with the NPDES.

- As required by Corps regulation, as well as local statute, the Corps must evaluate sites that have potential HTRW involvement.

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VII. REAL ESTATE REQUIREMENTS

A. DESCRIPTION OF AREA AND ESTATES REQUIRED

The project is currently designed to include two reservoirs or flood water detention sites of varying size, one dam modification, one lateral storage area and two levee systems. Except for the levee systems, most of the affected properties are currently floodplain and park land. Most are surrounded by residential properties, which generally are more densely populated in the southernmost areas. The levee systems will be constructed in residential and/or commercial areas. No Federally owned land is within the project area. Navigational servitude does not apply to this project.

Three sites lie within Lake County. Van Patton Woods Lateral Storage Area is located near the Village of Wadsworth. A determination has been made that the land acquisition for this area, will be used for mitigation. Therefore, fee acquisition for the project will consist of approximately 65.67 acres: a permanent levee easement of 14.20 acres; a permanent road easement of approximately 0.69 acres; and, a temporary work easement of 2.00. Buffalo Creek reservoir is located near the Village of Buffalo Grove in a public-owned forest preserve. Fee acquisition requirements are 68.80 acres: a temporary work easement of 63.85 acres; and, a permanent road easement of approximately 1.45 acres. North Fork Mill Creek Dam is located near the Village of Old Mill Creek. Fee acquisition requirements are 252.62 acres: a temporary work easement of 4.71 acres; and a permanent road easement of 5.07 acres.

Two levee sites are within Cook County. Levee 37 is located directly west of Prospect Heights and Mt. Prospect near areas of dense residential housing and commercial activities. The recommended LPP involves construction of the levee within a road right-of-way (ROW) or "road raise," thus, no permanent or temporary work easements are anticipated providing this work remains within the ROW. Levee 50 (Rand Park)) is near the City of Des Plaines between Dempster Street on the north and Oakton Street on the south parallel to River Road. Densely-populated residential/commercial development is located just to the west. A permanent levee easement of 4.41 acres, a temporary work easement of 1.28 acres, and fee acquisition of 2.02 acres for remaining uneconomic remnants.

Table 22 summarizes the land requirements for the project elements. Table 23 summarizes the estimated land acquisition costs for each project element. Borrow for the levee system and any clay liners needed for reservoirs or lateral berms will be taken from excavated materials from other completed cost shared projects, which are already owned in fee by the proposed local sponsors. These borrow sites are Reservoirs Numbers 15 and 27 of the North Branch, Chicago River project. Additional borrow material also will be available from Van Patton Woods.

Table 22 - Recommended Plan Real Estate Requirements

Site Element	Fee (acres)	Permanent Levee Easements (acres)	Flowage Easements (acres)	Temporary Work Easements (acres)	Permanent Road Easements (acres)	Temporary Road Easements (acres)
Van Patton Woods	65.67	14.20	-	2.0	0.7	0.0
North Fork Mill Creek	252.62	-	-	4.71	5.07	0.0
Buffalo Creek Reservoir Expansion	68.80	-	-	63.85	1.45	0.0
Levee 37 - Prospect Heights/Mount Prospect - Road Raise	0.0	0.00	0.0	0.0	0.0	0.0
Big Bend Lake Reservoir Expansion	29.14	8.88	27.72	27.46	0.0	0.0
Levee 50 - Rand Park	2.02	4.41	-	1.28	0.0	0.0
Totals	418.25	13.29	0.0	99.3	7.22	0.0

Table 23 - Estimated Real Estate Cost Summary

Site Element	Appraised Values [1]	Administration/ Relocation Costs	Contingency	Total Costs
Van Patton Woods	$344,000	$28,800	$71,680	$444,480
North Fork Mill Creek	$1,320,000	$28,800	$267,045	$1,615,845
Buffalo Creek Reservoir Expansion	$2,014,426	$37,800	$402,440	$2,454,666
Levee 37 [2]	$0	$12,800	$1,280	$14,080
Big Bend Reservoir Expansion	$2,316,000	$27,400	$455,940	$2,809,340
Levee 50 - Rand Park	$1,198,550	$348,800	$274,590	$1,821,940
TOTALS	$7,192,976	$484,400	$1,482,975	$9,160,351

[1] Appraised Values are at February 1998 Price levels

[2] Real Estate Costs for Levee 37 are limited to administrative costs. No real estate costs for the road raise are anticipated at this time.

B. LOCAL SPONSORS

The project will be sponsored by the State of Illinois (Office of Water Resources). An assessment of non-federal sponsors' real estate acquisition capability is complete. Responses to the capability questionnaire are on file in the Chicago District, Real Estate Division. The questionnaire may be found in Appendix G, Real Estate.

Illinois Department of Natural Resources, Office of Water Resources has furnished financial assistance in land acquisition on other projects and are expected to participate in real estate acquisitions associated with this project.

C. MINERALS

Research conducted using United States Geological Survey Maps, revised as of 1993, indicated no mining activities are located in the immediate vicinity of any of the project sites. There have been recent quarry activities at two sites in the vicinity, but mining activities have been abandoned at both sites. One site is four miles southeast of the Mill Creek Reservoir and the other site is 10 miles southeast of the Mill Creek Reservoir. These sites have been converted to water retention areas. No mineral acquisitions are contemplated for this project.

D. FACILITY/UTILITY RELOCATIONS

A preliminary survey of public utility companies operating within the areas of the proposed sites is complete. Several recreational trails and features on park lands will also be relocated or compensated for as damages to the lands. A preliminary opinion of compensability is provided in the Real Estate Appendix. Further investigation will be completed during the design phase of the project.

The project as currently designed will require two Public Law 91-646 relocations in the area of levee 50. One other improved but vacant lot on Levee 50 will require fee acquisition due to the fact that the levee construction will leave an uneconomic remnant. Levee 37 will be built in whole on an existing road right-of-way; thus, no Public Law 91-646 relocations will be required.

E. HTRW & EIS CONSIDERATIONS

No known HTRW concerns exist for the project as currently planned. However, areas of concern (LUST Sites and RCRA Sites) were identified within ½ to 1 mile of 4 of the 6 project sites. Follow up investigations will be performed on the areas of concern during the next phase of design. Additional information regarding the HTRW investigation is contained in Appendix H, HTRW.

In regards to environmental impacts, State-listed endangered bird species have been sighted foraging at the proposed Buffalo Creek Reservoir. Iowa Darters, also state-listed as endangered, were observed downstream of Old Mill Creek within the past 20 years. Additional information regarding environmental considerations is contained in the Environmental Impact Statement.

VIII. OPERATION AND MAINTENANCE REQUIREMENTS

Operation and Maintenance requirements for each type of project feature are outlined in the following paragraphs. Operations and Maintenance costs have been developed for the maintenance of each feature of each project component. A detailed listing of the tasks for both the non-federal sponsor and the federal government (inspections) is contained in Appendix C, Cost Estimates. A synopsis of the operation and maintenance tasks are described in the following sections.

A. LEVEES AND LATERAL STORAGE AREA

Regular operation and maintenance after project construction will be performed by the project sponsors. Maintenance of the levees and lateral storage areas will involve keeping the grass surface mowed and free from excessive tree and brush growth in order to preserve the integrity of the levees and to allow for periodic inspections. The selected plantings will be conducive to minimize mowing and to allow proper maintenance by the project sponsors. As with all projects, the levees should be monitored for erosion.

Normal routine maintenance will be required to insure long-term stability of the levees and lateral storage areas. The planting on the levees will be a grass mix that will be dense and will stabilize the slopes against erosion and minimizes mowing. A routine inspection of the levees to remove any tree saplings is required under this plan. The inspection would be necessary once a year. The inspection would be a walk through type of inspection. If there should be a need to routinely mow the grass several methods have been identified such as: bat wing configured mower, positive track boom type mower, and a low profile tractor. All can operate successfully on a levee with side slopes recommended in this application. Annual operation and maintenance costs are estimated to be between $5,000 and $64,000 for each levee or lateral storage area.

B. RESERVOIRS

Sedimentation associated with the reservoir designs is considered minimal because the inlets to the reservoirs are elevated above the invert of the river and discharges will be diverted into the reservoirs on an infrequent basis. For cost estimating purposes approximately 5 acre-ft of sedimentation is estimated for a 50-year life. It is estimated that sediment removal will be an O&M activity about once every 20 years. O&M for these projects including O&M for the pump stations projected to be between $18,000 and $21,000 (October 98 price levels) each. A more detailed break down of the O&M requirements is provided in the Appendix C, Cost Estimating.

C. OVERALL PROJECT

The flood warning system (Appendix I) on the Des Plaines River will be used in conjunction with the project plan to provide response time for required operation of the projects. The flood warning plan will be finalized during the detailed design phase of the project. Sandbag flood fighting is required only for infrequent events on various sections at each levee. The flood warning system will be activated in time to provide the required response time to install sandbags at specified points for flood fighting. Flood fighting with regard to the levee will be accomplished by generally available equipment and predetermined material sources.

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IX. ENVIRONMENTAL, SOCIAL AND CULTURAL IMPACTS

A. RECOMMENDED PLAN IMPACTS

An analysis of construction and operational impacts of the recommended plan was conducted to determine the extent of adverse impacts to archaeological, biological, historic, physical, and social resources. No adverse impacts are anticipated to archaeological, historic, and physical resources. Prior to any construction, Phase I archaeological surveys (and any further detailed investigations) will be required at Levee 37 and Big Bend Lake to determine whether any archaeological resources would be impacted by the feature construction. Phase I surveys have been completed at the other four sites.

Only minor temporary impacts to air and water quality are anticipated as a result of construction traffic and activities. There should actually be a net improvement in water quality as a result of the proposed wetland restoration program. Some adverse impacts to social resources may result due to loss of tax revenues from the conversion of private lands to public lands and changes in aesthetic character in the excavated material storage pile areas. The major adverse impact to biological resources would be the loss of about 24 acres of wetlands. No adverse impacts are expected to aquatic resources or endangered and threatened species.

B. WETLAND MITIGATION

Wetland mitigation of 65 acres at Buffalo Creek and Van Patton Woods will be performed to mitigate for the impacts of the Recommended Plan. Additional benefits will result from the restored as well as created wetland areas. The wetland should provide flood reduction benefits when it matures and the mitigated area returns to a former hydrologic condition. In addition to the flood reduction benefits, these mitigated wetlands would contribute to the continued improvement of the Des Plaines River water quality and provide higher quality wildlife habitat.

X. PLAN IMPLEMENTATION

A. AUTHORIZATION

The normal procedure leading to implementation of a Corps of Engineers' water development project that is authorized by the Congress is as follows:

- The report is released for a 45-day public review. The public review period initiates with the publication of a public notice in the Federal Register. Copies of the report and the Environmental Impact Statement will be issued to interested parties advising them of the report recommendations. At this time, interested parties will have an opportunity to present written views on the report for consideration.

- At the completion of the review period, and following a review of the written comments, the report will be reviewed by the Division Engineer. The Division Engineer's notice will be signed. Then, the report will be forwarded to the Washington Headquarters who will forward the report and the final EIS to the Governor of the State of Illinois and to other interested agencies for a 30-day review and comment period.

- Following the state and agency review, the final report of the Chief of Engineers will be forwarded by the Secretary of the Army to the Congress, subsequent to seeking the comments of the Office of Management and Budget regarding the relationship of the project to the program of the President.

- Congressional authorization of the project would then be required. This procedure would include review hearings by the appropriate congressional committees, and subsequent authorization in a water resources development act. Pre-construction engineering and design studies and construction would be completed consistent with funds appropriated by the Congress. The District Engineer would prepare detailed design reports, plans and specifications, and an updated engineering estimate of cost for each project element, bids would be invited, and a contract awarded.

- Following completion of the project, local interests would be responsible for project operation and maintenance.

B. IMPLEMENTATION RESPONSIBILITIES

Prior to implementation of the selected project, a non-Federal public agency (or agencies), legally empowered under state law and financially capable, must enter into a written agreement with the United States to ensure the required local cooperation. The sponsor(s) would be required to furnish the apportioned local share of the cost of the

project; perform or furnish to the United States funds to design and construct any required relocations; obtain all easements and rights-of-way for construction, operation and maintenance of the project; and, operate and maintain the project including the flood warning system.

A preliminary financial analysis of the local sponsors' capability to support the construction costs and annual operation and maintenance costs has been completed. It establishes the strong fiscal condition of the potential local sponsors and their ability to provide the local funding requirements. The detailed analysis is contained in Section 10b, Appendix E, Economic Analysis.

Based on Section 202c, of the Water Resources Development Act (WRDA) of 1996, within one year after the date of signing a Project Cooperation Agreement, the local sponsor(s) will be required to prepare a flood plain management plan designed to reduce the impact of future flood events in the project area. The plan will be prepared in accordance with guidelines development by the Federal Government and must be implemented not later than one year after completion of construction of the project. All of the communities in the project area participate in the National Flood Insurance Program (NFIP) therefore they may already be in compliance with this policy. The local sponsor(s) will need to review Corps of Engineers' policy to ensure that the FEMA accepted floodplain management plan is still valid given the impact of the proposed project and include consideration to preservation and enhancement of natural flood plain values.

The local share of the overall project cost is specified in the following section on cost allocation/apportionment. Cost sharing is based on costs allocated to the project purposes. The cost allocation and cost apportionment in the following paragraphs are based on the application of requirements established by the Water Resources Development Act of 1996, Public Law 99-662.

1. Cost Allocation/Apportionment

The general policy relating to the distribution of project construction costs between Federal and non-Federal interests is based on the allocation between general and local benefits to be derived from the project. The United States contributes in proportion to the general benefits and non-Federal interests contribute in proportion to the local benefits. As established in PL 99-662, project costs are shared with the local sponsor in accordance with project outputs. Project elements providing flood damage reduction benefits are cost shared based on the cost sharing provisions for flood damage reduction in section 202(a) of the 1996 Water Resources Development Act (WRDA) and Section 103(a) and Section 103(b) of the 1986 WRDA. These sections require non-Federal interests to pay, in cash, 5 percent of the cost of the project assigned to structural flood control during construction and to provide all lands, easements, rights-of-way, excavated material disposal areas, and relocations (LERRDs). The 1996 WRDA established the minimum total cost share at 35 percent and the maximum cost share at 50 percent of the

total project costs for structural flood control projects, 35 percent for environmental restoration and 50 percent for recreation. Table 24 contains a breakdown of the cost apportionment of costs between Federal and non-Federal interests based on flood damage reduction benefits.

Table 24 - Cost Apportionment of the Recommended Plan

Total Project Cost[1]	$48,999,899
65% Federal	$31,849,934
35% Non-Fed	$17,149,965
Non-Fed LERRD's	$10,921,952
5% Non-Fed Cash	$2,449,995
Additional Non-Fed Cash	$3,778,018
Total Non-Fed Contribution	$17,149,965

[1] All costs are for flood damage reduction

2. Local Cooperation Requirements

The specific items of local cooperation that must be accomplished by non-Federal interests in connection with the selected plan are outlined in the Recommendations section. Prior to initiation of construction, the project sponsor will be required to enter into a written Project Cooperation Agreement with the United States in accordance with the provisions of Federal law agreeing to furnish the required items of local cooperation. The State of Illinois (Illinois Department of Natural Resources, Office of Water Resources) has indicated that they will be the primary sponsor for the project implementation. Lake County, the Metropolitan Water Reclamation District of Greater Chicago, the Village of Mount Prospect, the Village of Prospect Heights, and the City of Des Plaines have all tentatively agreed to be co-sponsors for the implementation of separate elements of the recommended plan. The State has indicated that while it will serve as the primary local sponsor, it will require that local municipalities co-sign the PCA and agree to perform required project operation and maintenance for a particular element of the project. Each local sponsor will be required to enter into the written Project Cooperation Agreement as outlined below.

At the time of submittal of this report, an application requesting credit for design and construction of Levee 50 has been received from the non-Federal sponsors under section 104 of 1986 WRDA. The District is preparing to forward a recommendation through the Division Engineer and the Chief of Engineers to the Assistant Secretary of the Army (Civil Works) in accordance with ER 1105-2-29, Water Resources Policies and Authorities, General Credit for Flood Control, dated 18 November 1987. The District recommends that credit be approved for the non-federal construction of Levee 50 (Rand Park).

3. Views of Non-Federal Sponsors

A letter from each potential local sponsor for the design and construction is included in Appendix F, Coordination. A letter of intent from the State of Illinois, Department of Natural Resources, Office of Water Resources, indicating their intent to provide the required local cooperation items.

4. Coordination, Public Views, and Comments

In order to formulate a satisfactory plan for flood damage reduction in the Upper Des Plaines River watershed, the Corps of Engineers coordinated with many state and local agencies, local public officials, and private interests.

During 1988, at least 15 public meetings were held in the affected villages and towns to gather flood damage information for the reconnaissance study. During the period from 1993 to 1997, at least 14 public meetings were sponsored by various agencies including Illinois Department of Natural Resources, Office of Water Resources; Northeastern Illinois Planning Commission; and the Lake County Stormwater Management Commission. These meetings were held to discuss the approach to plan formulation, request assistance in locating potential project sites, address questions and concerns of residents and local officials, and review the locally preferred plan.

The Corps of Engineers also conducted coordination meetings with state and local interests. From 1995 through 1997, Corps representatives participated in more than 20 meetings with agencies including Cook County Forest Preserve District; Lake County Forest Preserve District; Illinois Department of Natural Resources-Office of Water Resources; Kenosha County, Wisconsin; State of Wisconsin; and, Lake County Stormwater Management Commission.

XI. CONCLUSIONS

This report summarized the Feasibility phase of a study of a plan for urban flood damage reduction in the Upper Des Plaines River watershed. It represented a coordinated planning effort in which state and local agencies, local public officials, and private interests were able to reach a consensus. The plan reflects the results of trade-offs to achieve maximum public acceptability.

The current proposed flood damage reduction project for the Upper Des Plaines River has an overall benefit-cost ratio of 1.70 including the cost of fish and wildlife mitigation measures. Based on an incremental benefit-cost analysis and the required risk based analysis, Corps of Engineers' participation in implementation of the recommended project features is justified. The project features include one dam modification, one lateral storage area, expansion of two reservoir expansion, two levees, a flood-warning preparedness plan and remapping of the mainstem Upper Des Plaines floodplain at the end of project construction. The total storage volume is 1,975 acre-feet.

In view of the flood damage reduction benefits that would be realized and the public consensus that has been reached, it is concluded that implementation of the features identified in the previous paragraph is desirable. It is further concluded that Corps of Engineers' participation in implementation of the project features should be recommended for Congressional authorization and funding.

XII. RECOMMENDATIONS

I have considered all significant factors which bear on the public interest relative to construction of the proposed flood damage reduction projects in the Des Plaines River Basin, including the engineering feasibility and the economic, environmental, social, and related impacts. The views and comments of other agencies also have been reviewed and considered.

I recommend that flood damage reduction for the Des Plaines River basin be authorized for implementation in accordance with the Recommended Plan described in this report, with such modifications thereof as in the discretion of the Chief of Engineers, may be advisable. I recommend that the Federal share be in accordance with the cost sharing, financing and other requirements of Section 103(c) of the Water Resources Development Act of 1986 (P.L. 99-662), as amended by Section 202(a) of WRDA 1996, and be limited to the Federal share of the recommended plan formulated for flood damage reduction including six structural elements and a flood warning plan, with all costs exceeding that limit to be a non-Federal responsibility. The total estimated first cost of the recommended plan is approximately $48,800,000, with an estimated Federal first cost of about $31,700,000. Prior to initiation of construction, local interests will enter into an agreement with the Secretary of the Army to provide the following items of local cooperation:

a. Provide a minimum of 35 percent, but not to exceed 50 percent, of the separable project costs allocated to flood control, 35 percent of the separable project costs allocated to environmental restoration, and 50 percent of the separable project costs allocated to recreation as further specified below:

(1) Enter into an agreement that provides, prior to construction, 25 percent of pre-construction engineering and design (PED) costs;

(2) Provide, during construction, any additional funds needed to cover the non-Federal share of PED costs;

(3) Provide, during construction, a cash contribution equal to 5 percent of flood control project costs;

(4) Provide all lands, easements, and rights-of-way, including suitable borrow and excavated material disposal areas, and perform or assure the performance of all relocations determined by the Government to be necessary for the construction, operation, and maintenance of the project;

(5) Provide or pay to the Government the cost of providing all retaining dikes, wasteweirs, bulkheads, and embankments, including all monitoring features and stilling basins,

that may be required at any excavated material disposal areas required for the construction, operation, and maintenance of the project; and

(6) Provide, during construction, any additional costs as necessary to make its total contribution equal to 35 percent of the costs allocated to flood control, 35 percent of the costs allocated to environmental restoration, and 50 percent of the costs allocated to recreation.

b. For so long as the project remains authorized, operate, maintain, repair, replace, and rehabilitate the completed project, or functional portion of the project, at no cost to the Government, in accordance with applicable Federal and State laws and any specific directions prescribed by the Government.

c. Grant the Government a right to enter, at reasonable times and in a reasonable manner, upon land that the local sponsor owns or controls for access to the project for the purpose of inspection, and, if necessary, for the purpose of completing, operating, maintaining, repairing, replacing, or rehabilitating the project.

d. Assume responsibility for operating, maintaining, replacing, repairing, and rehabilitating (OMRR&R) the project or completed functional portions of the project, including mitigation features, without cost to the Government, in a manner compatible with the project's authorized purpose and in accordance with applicable Federal and State laws and specific directions prescribed by the Government in the OMRR&R manual and any subsequent amendments thereto.

e. Comply with Section 221 of Public Law 91-611, Flood Control Act of 1970, as amended, and Section 103 of the Water Resources Development Act of 1986, Public Law 99-662, as amended, which provides that the Secretary of the Army shall not commence the construction of any water resources project or separable element thereof, until the non-Federal sponsor has entered into a written agreement to furnish its required cooperation for the project or separable element.

f. Hold and save the Government free from all damages arising from the construction, operation, maintenance, repair, replacement, and rehabilitation of the project and any project-related betterments, except for damages due to the fault or negligence of the Government or the Government's contractors.

g. Keep and maintain books, records, documents, and other evidence pertaining to costs and expenses incurred pursuant to the project to the extent and in such detail as will properly reflect total project costs.

h. Perform, or cause to be performed, any investigations for hazardous substances that are determined necessary to identify the existence and extent of any hazardous substances regulated under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), 42 USC 9601-9675, that may exist in, on, or under lands, easements or rights-of-way necessary for the construction, operation, and maintenance of the project; except that the non-Federal sponsor shall not perform such investigations on lands, easements, or rights-of-way that the

Government determines to be subject to the navigation servitude without prior specific written direction by the Government.

i. Assume complete financial responsibility for all necessary cleanup and response costs of any CERCLA regulated materials located in, on, or under lands, easements, or rights-of-way that the Government determines necessary for the construction, operation, or maintenance of the project.

j. To the maximum extent practicable, operate, maintain, repair, replace, and rehabilitate the project in a manner that will not cause liability to arise under CERCLA. As between the Federal Government and the non-Federal sponsor, the non-Federal sponsor shall be considered the operator of the project for the purpose of CERCLA liability.

k. Prevent future encroachments on project lands, easements, and rights-of-way that might interfere with the proper functioning of the project.

l. Comply with all applicable Federal and State laws and regulations, including Section 601 of the Civil Rights Act of 1964, Public Law 88-352, and Department of Defense Directive 5500.11 issued pursuant thereto, as well as Army Regulation 600-7, entitled "Nondiscrimination on the Basis of Handicap in Programs and Activities Assisted or Conducted by the Department of the Army," and Section 402 of the Water Resources Development Act of 1986, as amended (33 U.S.C. 701b-12), requiring non-Federal preparation and implementation of flood plain management plans

m. Comply with all applicable Federal and State laws and regulations, including Section 601 of the Civil Rights Act of 1964, Public Law 88-352, and Department of Defense Directive 5500.11 issued pursuant thereto, as well as Army Regulation 600-7, entitled "Nondiscrimination on the Basis of Handicap in Programs and Activities Assisted or Conducted by the Department of the Army".

n. Participate in and comply with applicable Federal floodplain management and flood insurance programs.

o. Comply with Executive Order 11644, "Use of Off-Road Vehicles on the Public Lands," dated 8 February 1972 as amended by Executive order 11989, dated 24 May 1997, which established policies and provides for procedures to ensure that the use of off-road vehicles on public land is controlled to protect the resources, promote safety of all users, and minimize conflicts among the various uses.

p. Provide the required non-federal share of total cultural resource preservation mitigation and data recovery costs allocable to each project purpose that are in excess of one percent of the total amount authorized to be appropriated for each project purpose.

q. Do not use Federal funds to meet the non-Federal sponsor's share of total project costs unless the Federal granting agency verifies in writing that the expenditure of such funds is expressly authorized by statute.

r. Inform affected interests, at least annually, regarding the limitations of the protection afforded by the project.

s. Prescribe and enforce regulations to prevent obstruction of or encroachment on the project that would reduce the level of protection it affords or that would hinder operation or maintenance of the project.

t. Provide and maintain necessary access roads, parking areas and other public use facilities, open and available to all on equal terms.

u. Comply with Public Law 90-483, as amended, which provides that fair and equitable fees will be assessed the users of specialized sites, facilities, equipment or services provided at substantial Federal expense.

The recommendations contained herein reflect information available at this time and current departmental policies governing formulation of individual projects. They do not reflect program and budgeting priorities inherent in the formulation of a national civil works construction program nor the perspective of higher review levels within the Executive Branch. Consequently, the recommendations may be modified before they are transmitted to the Congress as proposals for authorization and implementation funding. However, prior to transmittal to the Congress, the sponsor, the States, interested Federal agencies, and other parties will be advised of any modifications and will be afforded an opportunity to comment further.

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